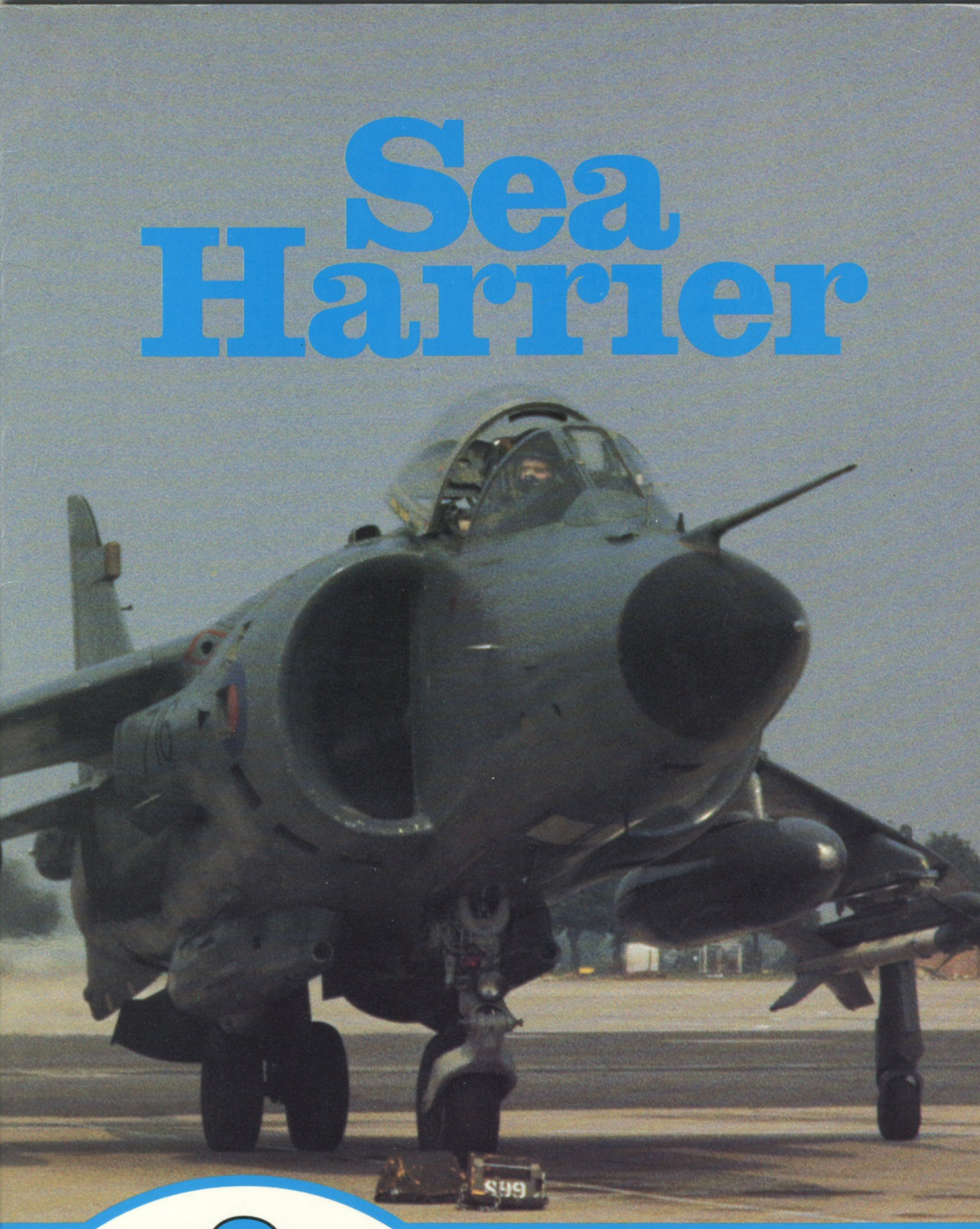
Sea Harrier



AEROGUIDE 3

BAe Sea Harrier FRS Mk 1

Sea Harrier

British Aerospace Sea Harrier FRS Mk 1

As these words are written, reactions to the new AEROGUIDE series are starting to become evident, and although it is early days at the moment the signs are that the books are being well received – sufficiently so, at least, to encourage the publication of Nos 3 and 4!

The publishers have received a fair amount of correspondence from all corners of the world, almost all offering constructive comment and suggestions concerning the subject matter and the format of future titles. Improvements will certainly be made and, it is hoped, new features will in time be incorporated, but many people have remarked upon the already high standard of photographic reproduction. In this connection mention must be made of the hard work undertaken by our printers, who expended a great deal of energy and filled some unscheduled hours in order to maximise quality.

AEROGUIDE 3 is the first in the series to consider a Fleet Air Arm subject; it deals with an aircraft that is, without exaggeration, one of the best known and most admired throughout the world and one of the few to be fully battle-proven in modern combat conditions. As in previous volumes, the emphasis of the content is on the external configuration of the airframe: for reasons of space it is impossible to give more than a passing mention of the complex subject of Sea Harrier paint schemes and markings, and in this respect reference to two excellent articles by Dick Ward in *Scale Models* magazine (February 1983 and May 1983 issues) is highly recommended.

Most of the previously unpublished photographs included in this volume depict aircraft serving with No 899 Naval Air Squadron, were taken on 9 August 1983 and show Sea Harriers in their typical land-based working environment. The coverage is not, and cannot be, exhaustive, but the publishers believe that it adds up to the most comprehensive visual appreciation of the aircraft yet available as a single volume, and a study of the illustrations will in all probability provide many readers with new information concerning the aircraft's less obvious details. As in AEROGUIDES 1 and 2, the photographer's brief does not extend to capturing views of cockpit interiors, and reliance is thus once again placed on the good offices of the airframe manufacturer; it can be fairly safely assumed that instrument panels, side consoles and/or interior fittings will differ in detail on service aircraft from the coverage given on page 23 of the present book.

'On site' photographs reproduced in AEROGUIDE 3 were taken by kind permission of the Officer Commanding, Royal Naval Air Station Yeovilton, and the publishers are very appreciative of the generous 'onboard' facilities granted by him; thanks are also due to Lt Cdr Brian Morgan, Public Relations Officer at Yeovilton (who kindly arranged the details of the photographers' visit and organised the provision of official HMS *Heron* prints) and to the members of No 899 NAS. Particular mention must also be made of the active assistance and encouragement given by British Aerospace at Kingston-upon-Thames, especially by Mike Stroud, John Godden and Harry Fraser-Mitchell, who arranged both for the supply of many BAe photographs and for a number of technical questions to be answered. For help with additional illustrations and guidance thanks go to Brian Limbrey of the Martin-Baker Aircraft Co Ltd and to Dick Ward of Modeldecal. Uncredited photographs are copyright Linewrights Ltd, to whom, incidentally, any enquiries concerning the content or availability of AEROGUIDES should be addressed. The publishers are always pleased to receive opinions from readers (and thank those who have taken the trouble to write already), but regret that no reception facilities are available at the editorial address.

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Front cover illustration: A Sea Harrier of No 899 NAS, RNAS Yeovilton, 1983

Back cover plate: A Sea Harrier FRS Mk 1 of No 809 NAS, HMS *Hermes*, 1983

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INTRODUCTION

At first acclaimed as, and subsequently proven to be, the most effective all-round naval combat aircraft in the world today, the Sea Harrier represents a concept that has long been discussed but one that has been put into practice only comparatively recently: the operation of V/STOL (Vertical/Short Take-Off and Landing) fixed-wing aircraft from warships. Postwar, carrier aviation has witnessed revolutionary changes as ships have been forced up to unprecedented dimensions in order to cope with ever faster and heavier aircraft and compelled to install more and more complex catapults and arresting gear in order to launch and recover them safely. The attraction of minimum-area flight decks from which aircraft could rise vertically and to which they might return in similar mode finally proved irresistible with the phasing out of the last of the Royal Navy's conventional carriers and, indeed, has caused navies with lower budgets to consider seriously the undoubted advantages of such economical sea-going platforms as the Sea Harrier suggests.

MULTI-ROLE RADAR

The Sea Harrier is a straight adaptation of the land-based Harrier that has served since 1969 with the Royal Air Force, differing from the current GR Mk 3 principally in the revised avionics necessary for the naval version to conduct its rather different missions and in the minor component changes (aluminium is substituted for magnesium in some engine details, for example) required better to resist corrosion. Externally, the most easily recognised difference is the Sea Harrier's completely revised forward contours, which now house the multi-mode Blue Fox radar (enabling the aircraft to perform air interception and air-to-surface search and attack), accommodate more comprehensive avionics and raise the cockpit by about 1ft, giving the pilot vastly improved visibility. Other revisions include the incorporation of lash-down lugs on the

Below: A Sea Harrier FRS Mk 1, inflight-refuelling probe fitted, is lashed down aboard a British carrier. *HMS Invincible*

undercarriage for stowage at sea, an enhanced braking system and better roll control facilities, the addition of an autopilot, and greater available movement for the horizontal stabilisers.

Power is provided by a single Rolls-Royce Pegasus 104 rated at 21,500lb at sea level and operating on the now-familiar vectored-thrust principle wherein bypass air is ducted through a pair of rotatable nozzles and jet exhaust via a further pair aft, thus giving a 'four-poster' downthrust to support the weight of the aircraft and provide vertical lift. In practice, however, Royal Navy Sea Harriers operate in the STOVL (Short Take-Off, Vertical Landing) mode, rolling take-offs by means of a bow ramp – 'ski-jump' – allowing launch runs to be cut by up to 60 per cent or, alternatively, weapons/fuel to be increased by up to 30 per cent. Maximum speed is reportedly in the region of 640kt. STOVL not only renders traditional equipment such as catapults and arrester wires redundant but also is almost uninhibited by ship speed and wind-over-deck.

AN EXCEPTIONAL AIRCRAFT

Sea Harriers first entered service with the Royal Navy in mid-1979, equipping the initial trials and training unit, No 700A Naval Air Squadron. No 700A subsequently became No 899 NAS, and the first fully operational squadron, No 800, was formed in April 1980. No 801 NAS was formed the follow-

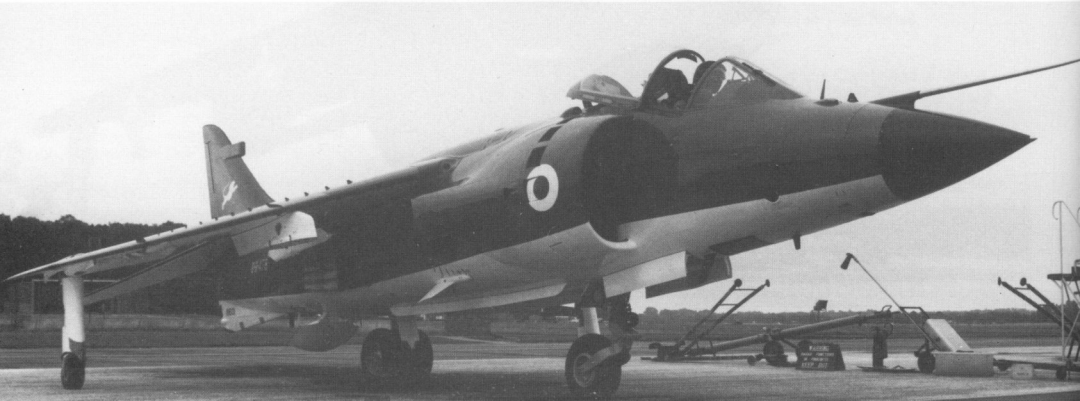
Above: Royal Navy Sea Harriers were originally finished in Extra Dark Sea Grey and white, as this February 1981 photo of a No 801 NAS aircraft shows. CBLSs are fitted to the outer wing pylons and on the fuselage station. *801 Naval Air Squadron*

Left: An Indian Navy Sea Harrier on flight trials. The aircraft is in primer finish, with dark grey upper fuselage and fin panels (although the pylon visible is white), and bears the temporary registration G-9-478. *British Aerospace*

Below: The same aircraft in Indian markings and serialled IN601. Indian Sea Harriers are designated Mk 51 by the manufacturers. *British Aerospace*

Opposite page top: Sea Harrier ZA174, with twin 30mm Aden gun pods and 100gal external fuel tanks clearly visible. *British Aerospace*

Opposite page bottom: A November 1983 photograph of one of the Royal Navy's three Harrier T Mk 4N trainers, in No 899 NAS markings. *HMS Heron*



ing year, and the Falklands conflict in the spring of 1982 saw the re-establishment of No 809 NAS. The original Sea Harrier contract covered two dozen machines, soon increased to 34; after the Falklands operations it was announced that a further 14 were to be procured for the Fleet Air Arm.

The aircraft operate from the modern light carriers *Invincible* and *Illustrious*, which are due to be joined by their sister-ship *Ark Royal*, currently (late 1983) fitting out. Shipboard trials were conducted from the more venerable *Hermes*, which has from time to time operated front-line complements of Sea Harriers and, indeed, was the flagship of the South Atlantic task force.

Events in the South Atlantic proved the Sea Harrier to be an exceptional combat aircraft, and it is no exaggeration to say that it, more than any other single factor, ensured the Falkland islanders' liberation. Its very flexibility enabled it to perform with great success in the air defence role, accounting for more than twenty enemy aircraft (quoted figures vary), and also to conduct gruelling attack and reconnaissance sorties.

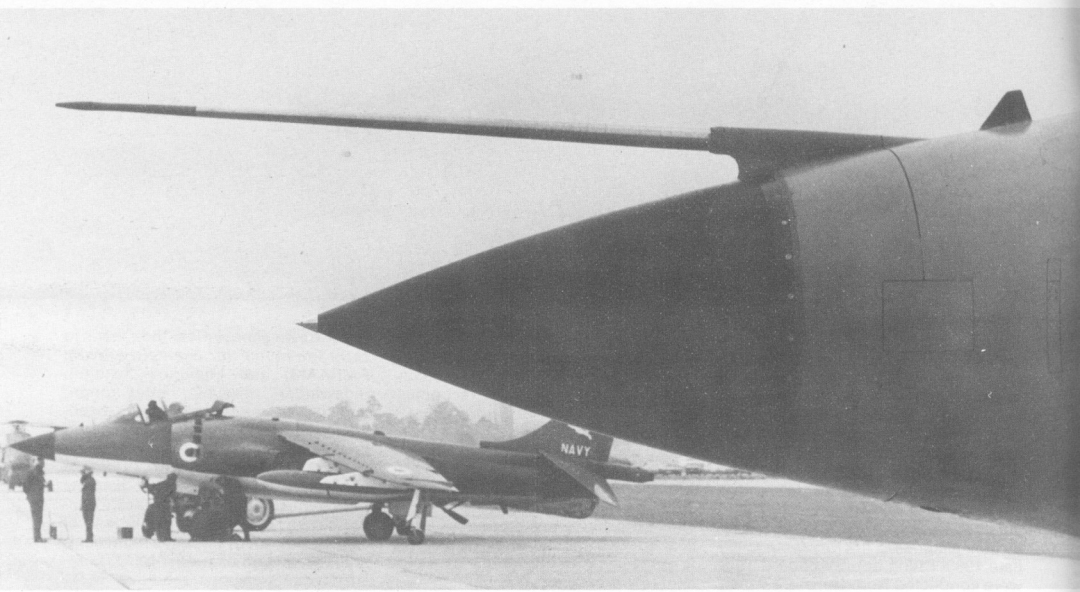
An order for six aircraft has been placed by the Indian Navy, now (reportedly) being increased to sixteen, for operation aboard the modified Majestic class light fleet carrier *Vikrant*. These machines are in essence identical to FRS Mk 1s serving with the Royal Navy, differing only to a minor degree with regard to equipment.

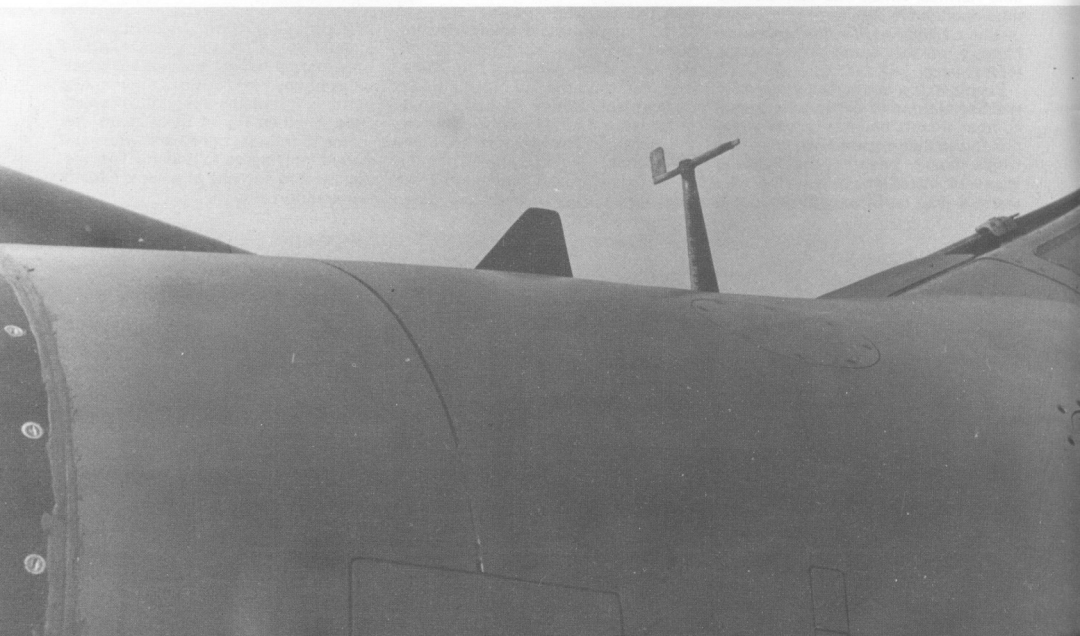
FOR THE FUTURE

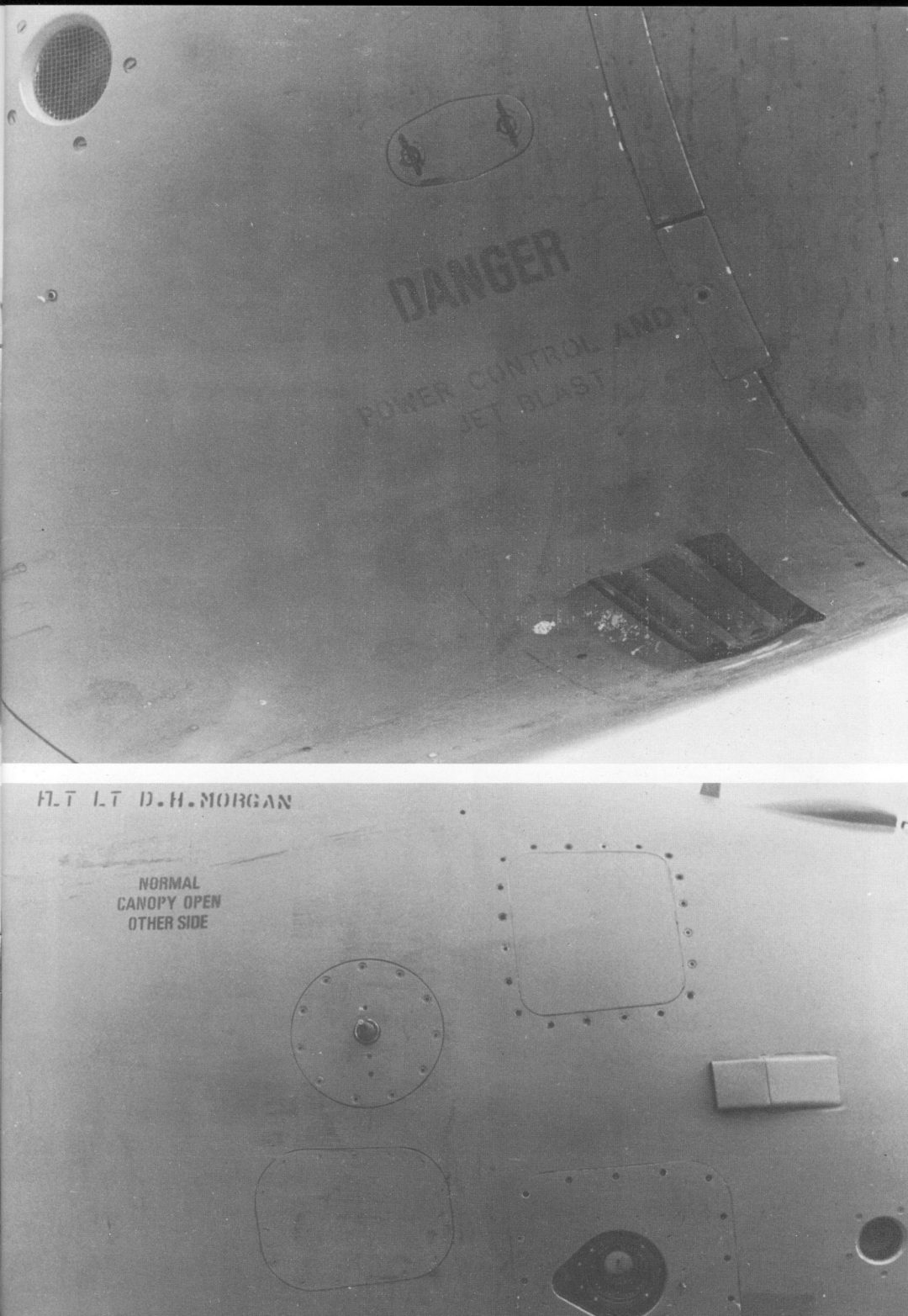
Three main areas of future development have been highlighted for the Sea Harrier, one affecting the aircraft itself and the other two its method of deployment. British Aerospace have proposed a mid-life refit programme, the main features of which are a new nose radar giving, amongst other advantages, greater range and Track-While-Scan (TWS) and look-down/shoot-down capabilities; the means to carry improved (for example AIM-20, AMRAAM) and additional (wingtip Sidewinder) missiles; better range; and leading-edge wing-root extensions (LERX). Operation at sea could be diversified by introducing the Ship-borne Containerised Air Defence System (SCADS), in which suitable merchant ships might be quickly converted for use by a detachment of V/STOL aircraft by adding a flight deck, a 'ski-jump' and container-based command and weapons modules. More radical is SkyHook (like SCADS, a BAe proposal), which envisages Sea Harriers operating from space-stabilised cranes on board ships which would incorporate hangar/maintenance facilities but no flight decks. At the time of writing, it remains a matter of conjecture whether any of these plans will come to fruition, but all are viable and would only serve to enhance the versatility and potency of what is already an amazing aircraft.

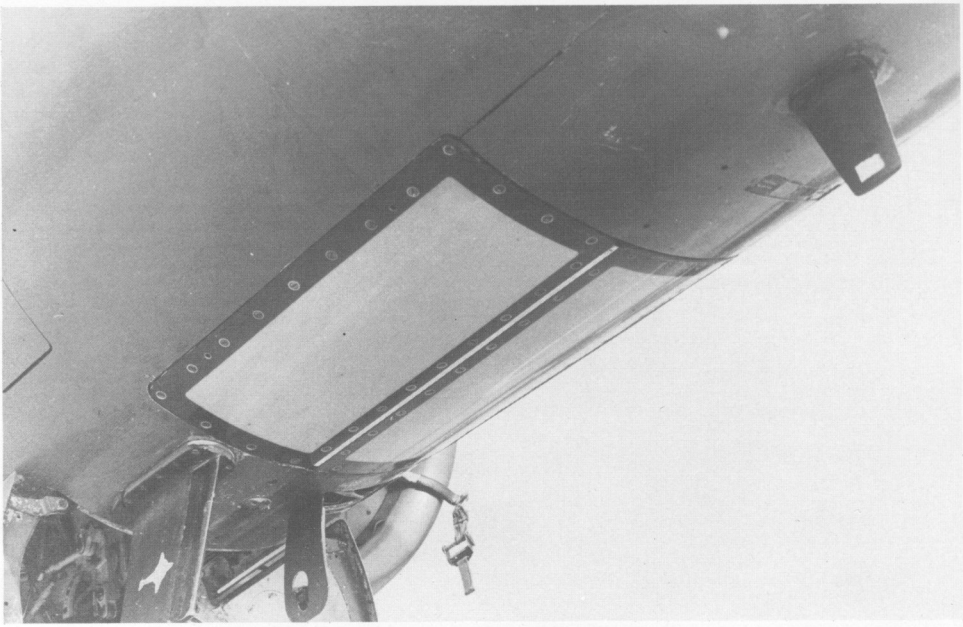
AIRFRAME

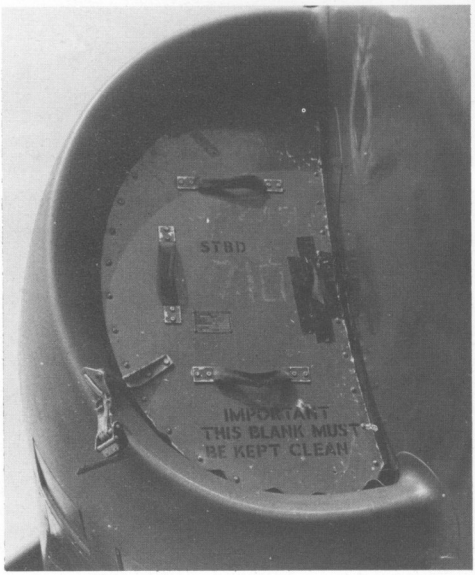
Below: Close-up of nose radome and pitot tube, Sea Harrier FRS Mk 1; radome folds to port for access to the Blue Fox radar and to aid aircraft stowage below decks. Note natural metal tip to nose. An Indian Navy aircraft is in the background.
Bottom: IFF (Identification Friend or Foe) antenna and yaw vane forward of the cockpit windshield; the IFF antenna is offset slightly to port. Note sealant around edge of radome.
Opposite page top: The Sea Harrier's conventional flight control surfaces are generally ineffective when the aircraft is hovering or flying below stalling speed, so air is ducted from the Pegasus engine and exhausted via reaction control valves (RCVs) at the wingtips, nose and tail. This is the nose valve, helping pitch control. Note grilled vent at top left.
Opposite page bottom: Starboard nose detail of XZ459/'716', No 899 Naval Air Squadron, August 1983, showing camera port, airflow direction detector etc.

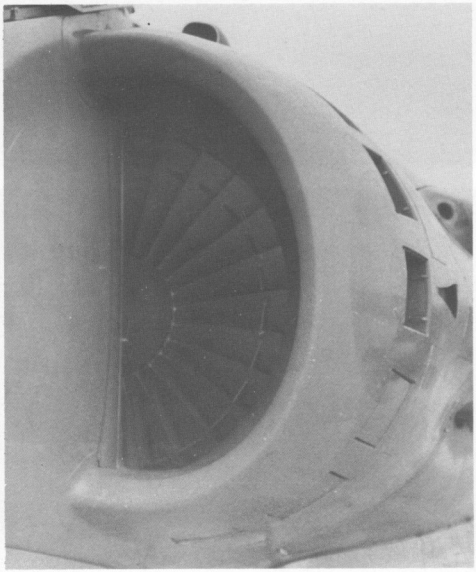





DANGER
POWER CONTROL AND
JET BLAST
FLT LT D.H.MORGAN
NORMAL
CANOPY OPEN
OTHER SIDE

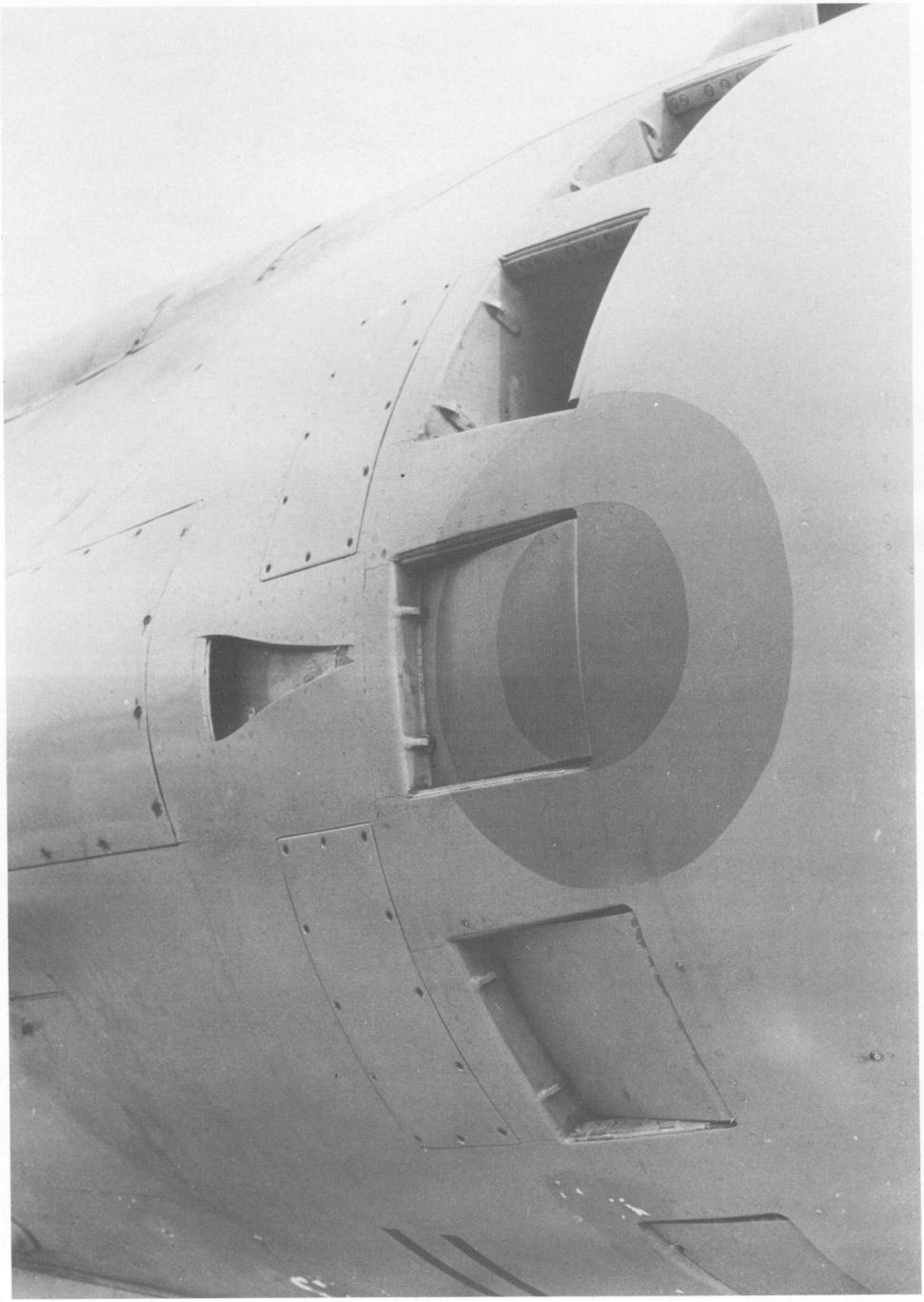




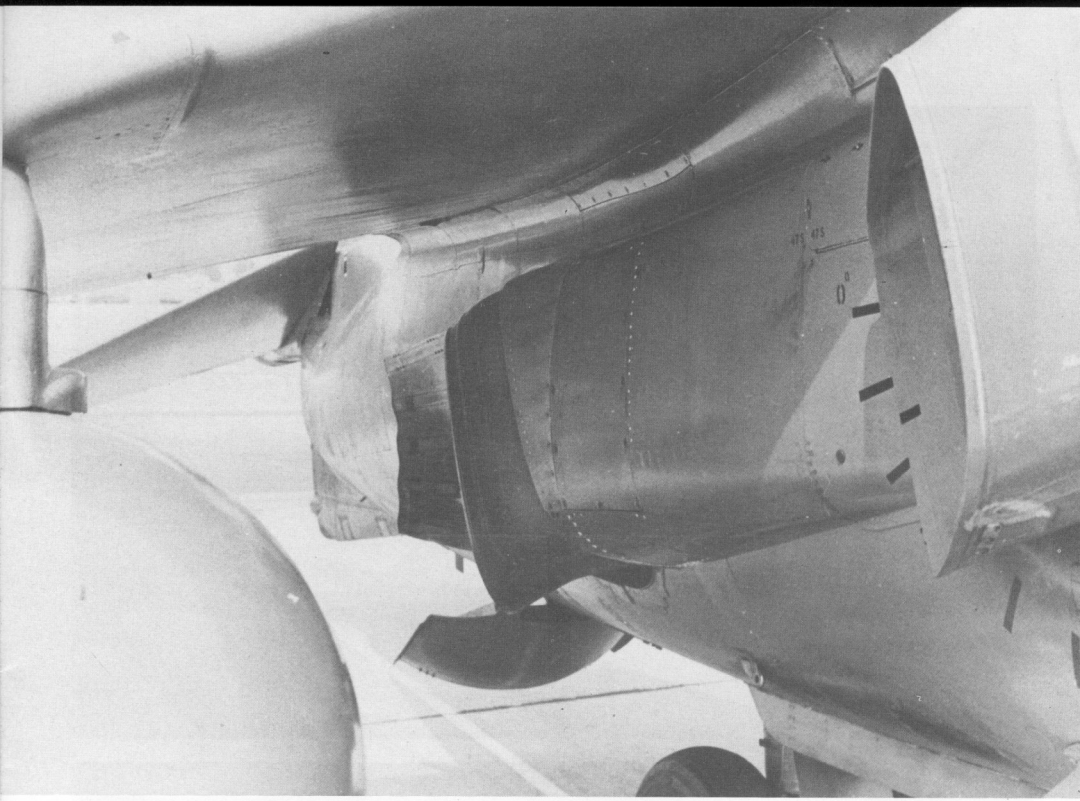


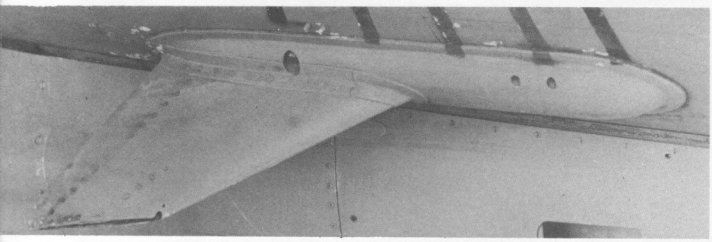
Top: The doppler radar panel below the Sea Harrier's nose; immediately aft of this, offset to starboard, is the TACAN (Tactical Air Navigation) antenna, whilst the blade forward is the I-band transponder. Doppler panels appear as a cream colour.

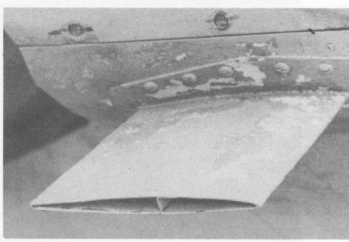
Above left: Starboard intake, with blank fitted to prevent ingestion of foreign matter. Blanks are generally painted red.
Above right: Port intake, showing fan detail.
Opposite page: Auxiliary intake doors, starboard side, with NACA intake further aft. The photo shows the typical attitude assumed by these doors on an inactive aircraft. Further points of interest are the trestle markings and the fact that the roundel does not quite live up to its definition! This is another No 899 NAS aircraft, August 1983.



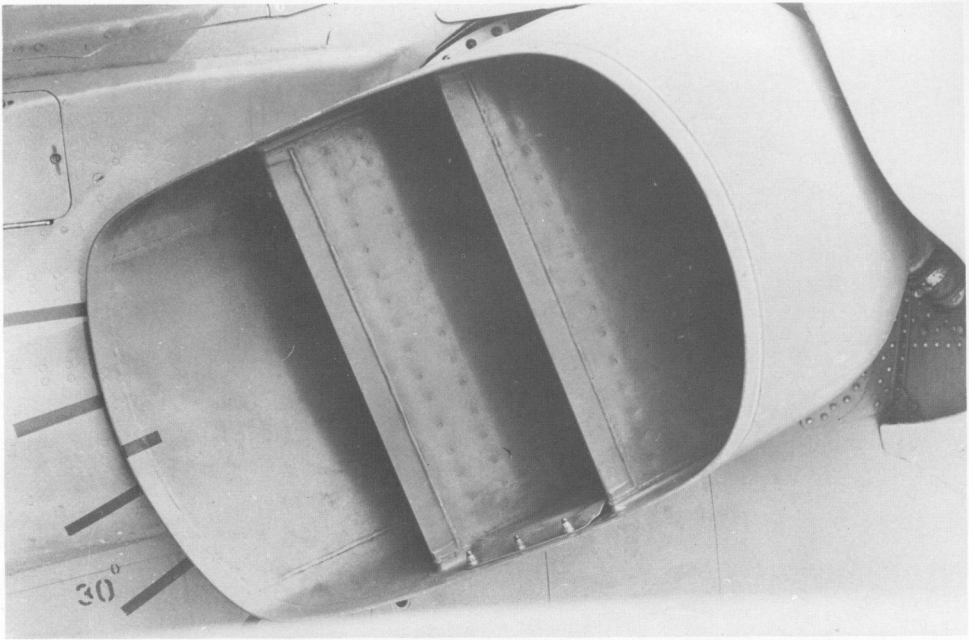
Above: Auxiliary air doors, port intake.
Right: Forward lower fuselage details of a Sea Harrier. This aircraft is shown with the twin ventral strakes fitted: these are essential to creating optimum 'air cushion' effects during vertical or short take-offs and landings, although the Aden gun pods (the locating lugs for which are clearly visible) provide similar conditions.
Opposite page top: Starboard wing root and after nozzle fairing. The aircraft's inboard wing pylon is carrying a 100gal combat tank.
Opposite page middle left: The aerodynamically faired fuel vent fitted to the lower contours of the Sea Harrier's fuselage, beneath the starboard forward nozzle fairing; the Aden pod is fitted below. Quadrant scale provides visual reference of nozzle angle – not for the benefit of the pilot of course!
Opposite page middle right: Oil vent installed on lower contours of starboard forward nozzle fairing.
Opposite page bottom: Port after nozzle fairing, showing the location of the Sea Harrier's refuelling/defuelling coupling access door (which hinges upwards), together with nearby stencilling. The Sea Harrier has five fuselage and two wing tanks, giving a total capacity of 632gal; external ferry tanks can double this, but 100gal or (more recently) 190gal tanks are usual.








REFUELLING MAXIMUM DELIVERY PRESSURE 50 P.S.I. 3·50KG/CM²
DEFUELLING MAXIMUM SUCTION PRESSURE 11 P.S.I. 0·8KG/CM² BELOW ATMOS.
GROUND(EARTH)HERE
F-34
F-40
F-44
NITROGEN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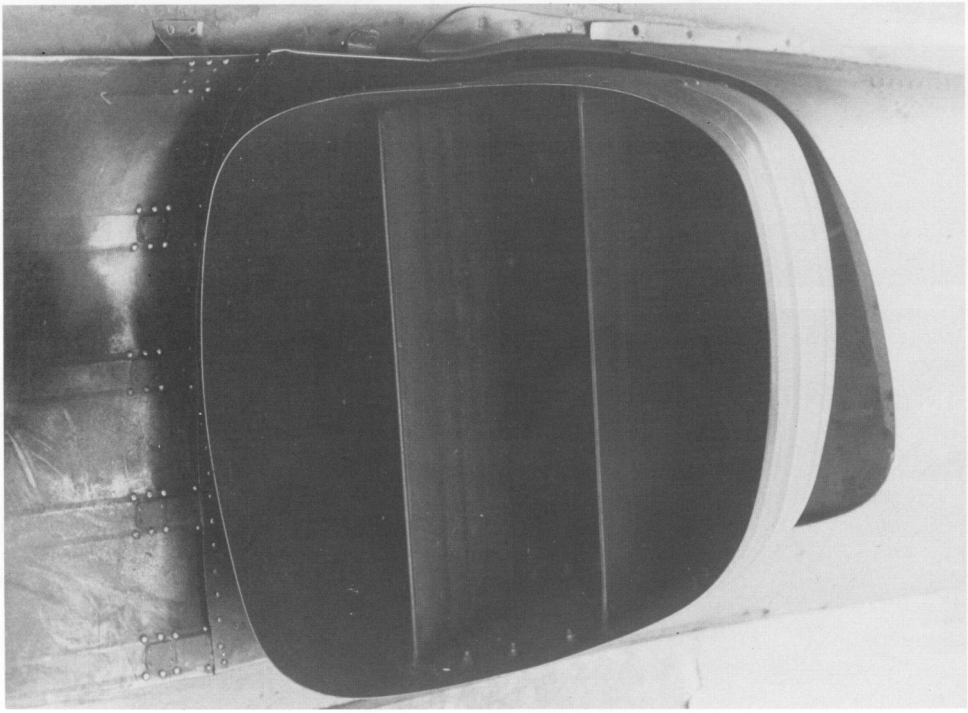
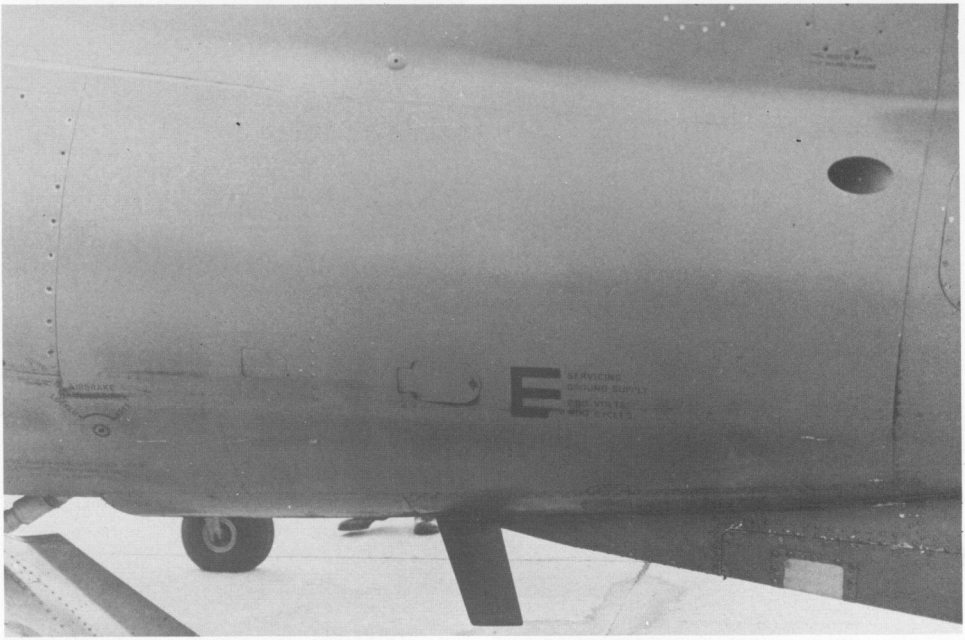
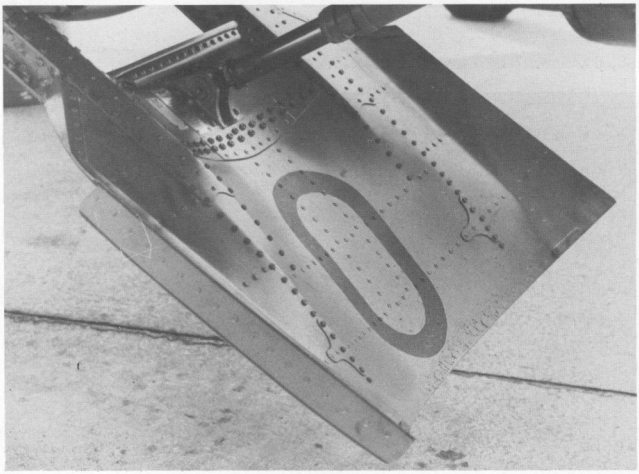
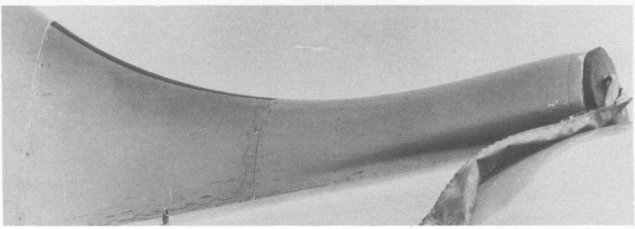


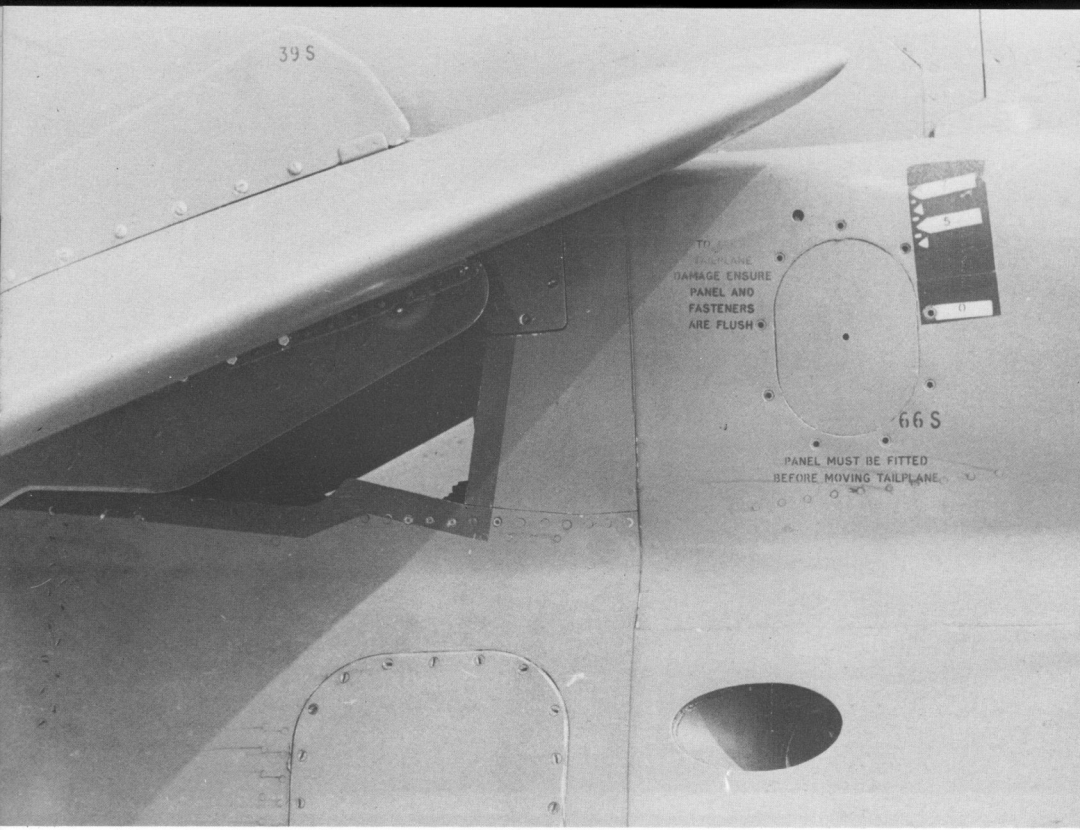






Opposite page top: Close-up of forward exhaust nozzle, starboard side. Each forward unit discharges fan bypass air, which is 'cold', and hence the surfaces are generally to be seen painted the same shade as the adjacent airframe.
Opposite page bottom: The rear nozzle on the starboard side; note that it is by no means identical in shape to the forward unit. The finish is stained natural metal, as is that of the deflector plate immediately aft. Nozzle control is achieved via a single lever in the cockpit (the only 'extra' a Sea Harrier pilot has to cope with as compared to a conventional aircraft). Transition from vertical take-off to forward flight requires rotation through 90°, but the nozzles can also be trained slightly forward, to give a measure of reverse thrust; rotation during flight gives the aircraft unrivalled manoeuvring capabilities (Vectoring in Forward Flight, or VIFF).
Above: Lower rear fuselage, port side, shows the prominent standby UHF antenna, offset from the centreline.
Left above: Interior of airbrake on a No 899 NAS Sea Harrier. This machine (XZ460/'710') shows the typical application of the last number of the aircraft code to the airbrake inner surface. Date is August 1983.
Left below: Intake duct at base of vertical stabiliser. Fin panel at left is HF notch antenna; note protected leading edge and small intake at base.


AYTUR
ROYAL NAVY
XZ460
XZ



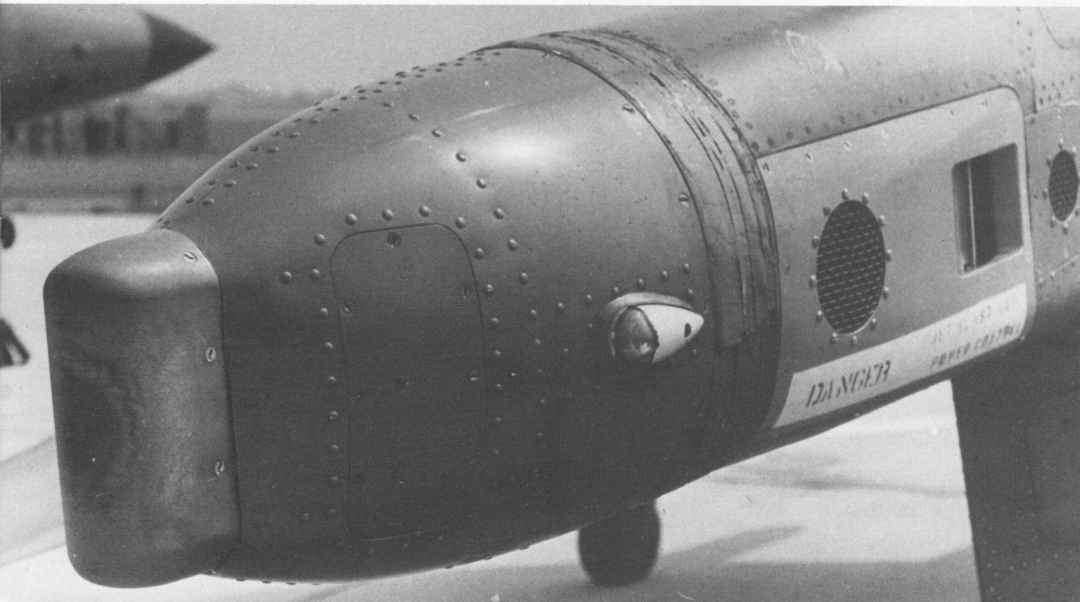
Opposite page top left: Vertical tail surfaces, showing Radar Warning Receiver (RWR) fairing and the latest (autumn 1983) variation of the No 899 NAS emblem.

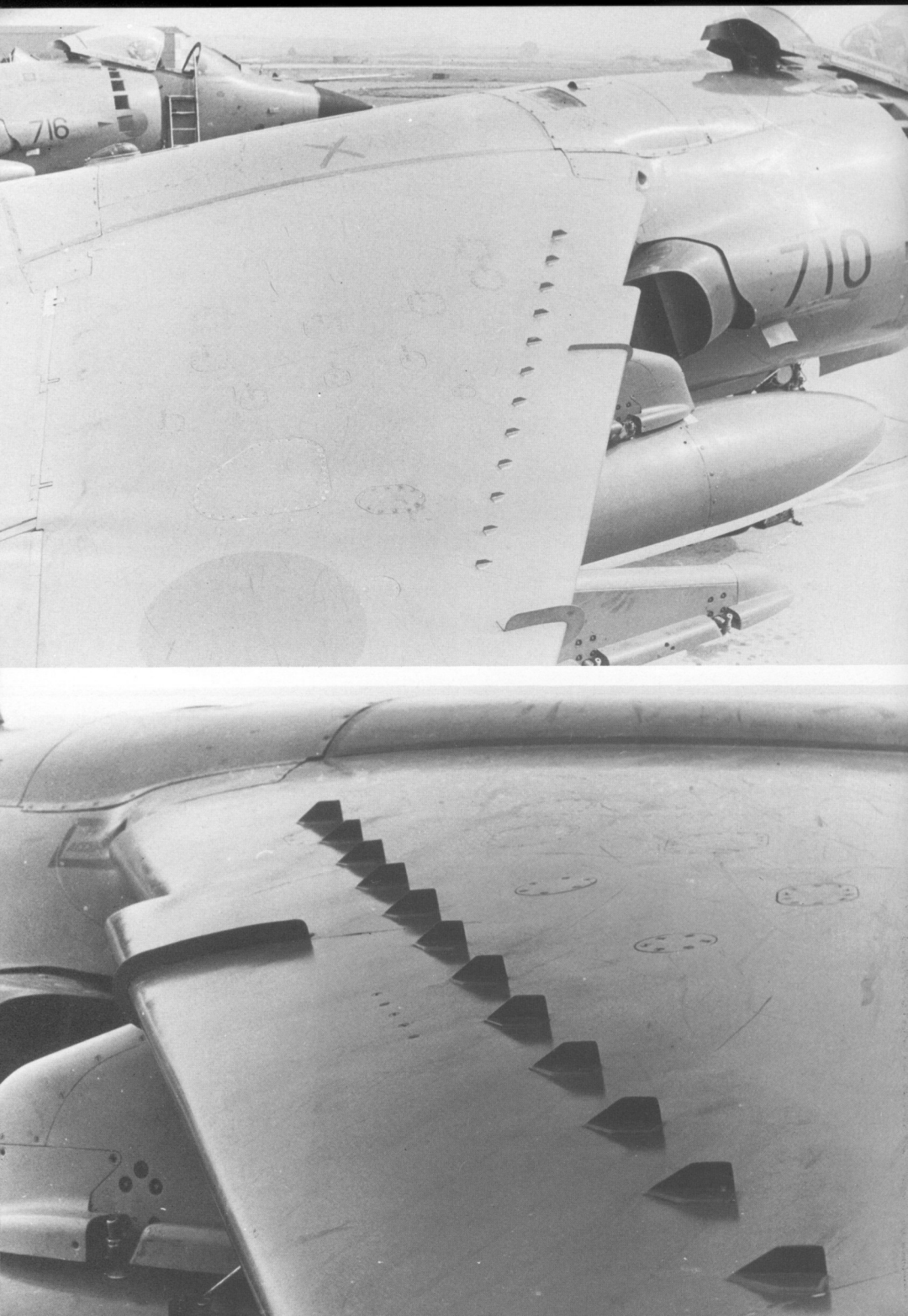
Opposite page top right: The port horizontal stabiliser of the same machine.

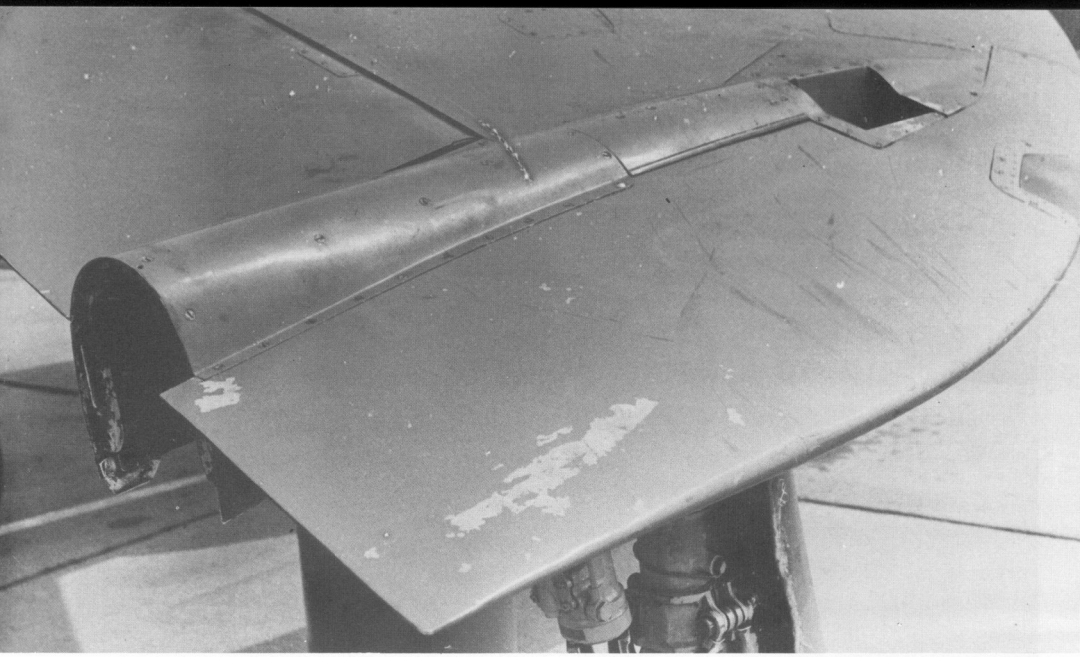
Opposite page bottom: Tip of XZ400's ventral fin, showing plastic tail bumper and profusion of rivets.

Above: Tailplane incidence markings and other details, starboard side.

Below: Tail boom RWR, lamp, vents and yaw RCV, starboard side.

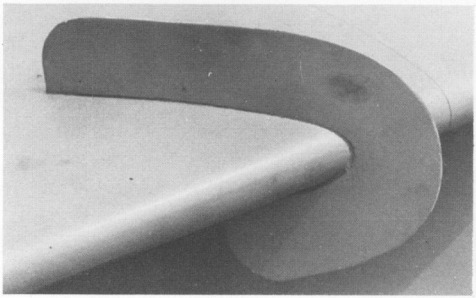


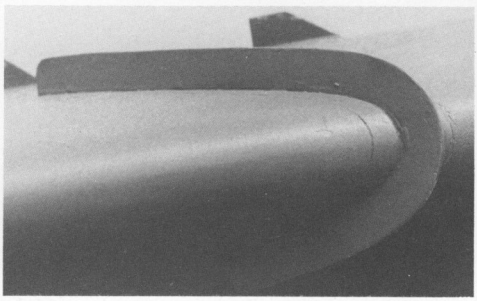

716
710

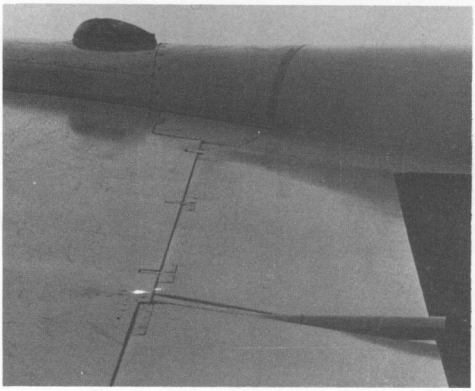


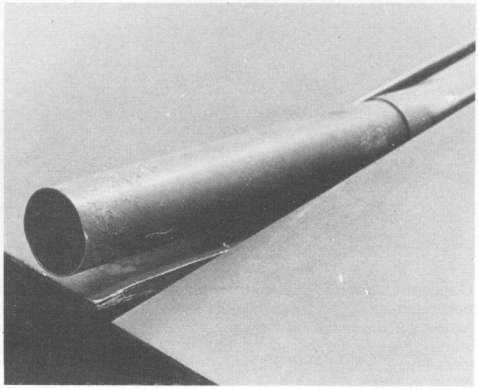
Opposite page top: Starboard wing upper surface. The grille on top of the fuselage is the outlet for the gas turbine starter; the inlet for the starter, not visible here, is further forward and offset to port.

Opposite page bottom: Vortex generators and inboard fence as fitted to the Sea Harrier's port wing.
Above: Starboard wing tip, showing shape of outrigger undercarriage fairing and position of RCV. Wingtip navigation light can be seen at extreme right.
Below: Wing root trailing edge area, highlighting the rather angular contours evident and the sharpness of the trailing edge itself. Anti-collision light atop fuselage is offset to port.



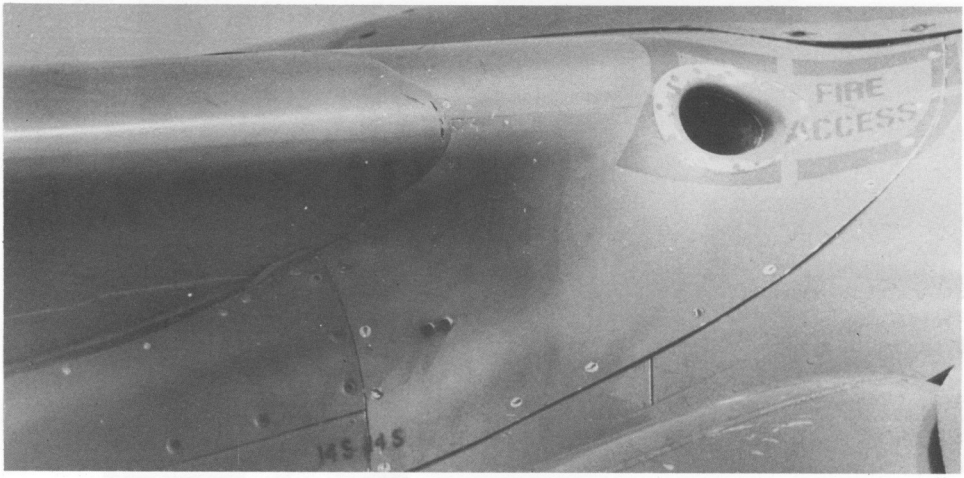


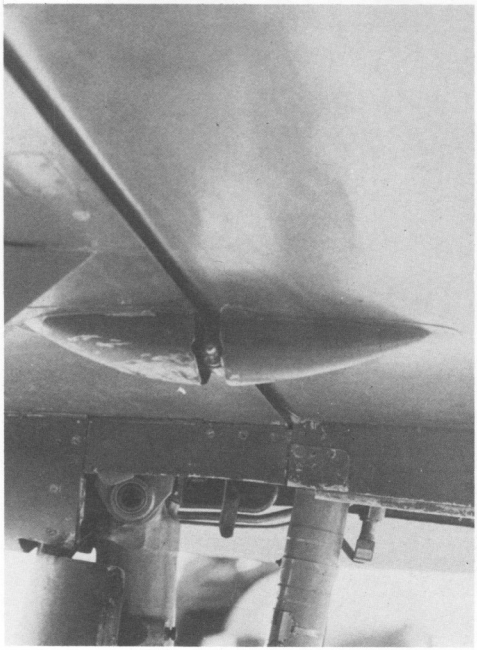


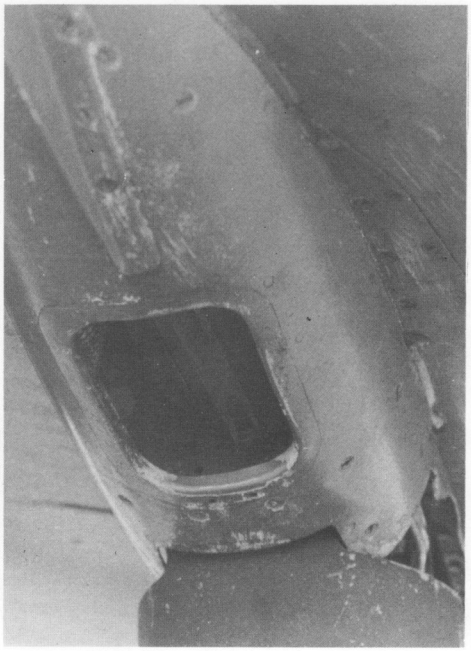



DANGER
POWER CONTROL
AND JET BLAST

Opposite page top left: Outboard wing fence, starboard side.
Opposite page top right: Inboard wing fence is less substantial.
Opposite page middle left: Port flap. The Sea Harrier's vectored thrust capabilities obviate the need for complex, lift/drag-inducing movable surfaces.
Opposite page middle right: Detail of fuel jettison pipe, located between flap and aileron.
Opposite page bottom: Close-up of starboard wingtip navigation light.
Below: Starboard wing root at the leading edge, showing engine cooling intake (which serves also as an aperture for a hose nozzle in the event of an engine fire).
Bottom left: Flap actuator fairing beneath starboard wing.
Bottom right: Close-up of RCV beneath port wing tip. Yaw and front pitch RCVs are controlled directly by the pilot, roll and rear pitch units via direct linkage to ailerons and horizontal stabilisers respectively.







UNDERCARRIAGE

Below: Starboard view of the Sea Harrier's nose undercarriage unit. General finish of all gear legs is glossy Pale Blue-Grey; this colour is standard and was appropriate to the aircraft in their original Fleet Air Arm scheme of Extra Dark Sea Grey and white. Note small gear door at rear of leg, attached to latter by free-moving struts.

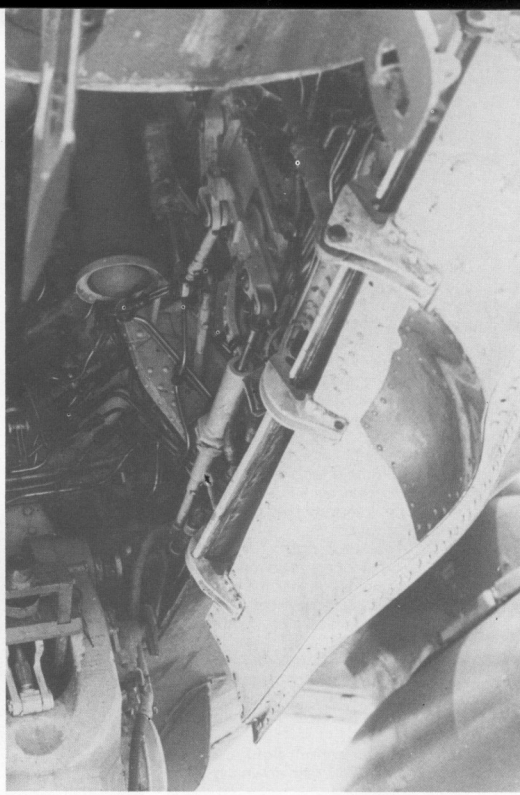
Opposite page top left: Nose gear from a different viewpoint. The landing lamp is very evident, its casing in a black finish. Note 'eyes' further aft for lashing down the aircraft.

Opposite page top right: View showing detail of interior of port nosegear door, painted white.

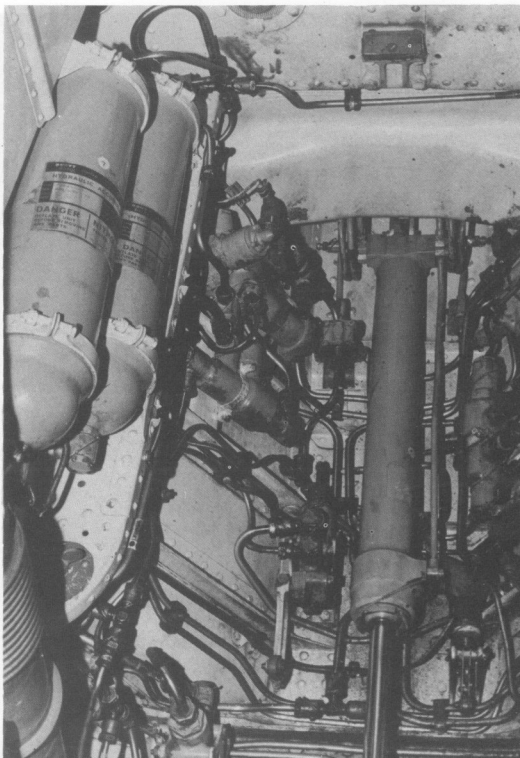
Opposite page bottom left: The Sea Harrier's forward nosewheel doors are sometimes to be seen closed when the aircraft is at rest but they can be opened manually via this valve for inspection, maintenance etc. Stencilling above is in black.

Opposite page bottom right: Just part of the mass of piping etc inside the nosewheel bay. Base finish is white.

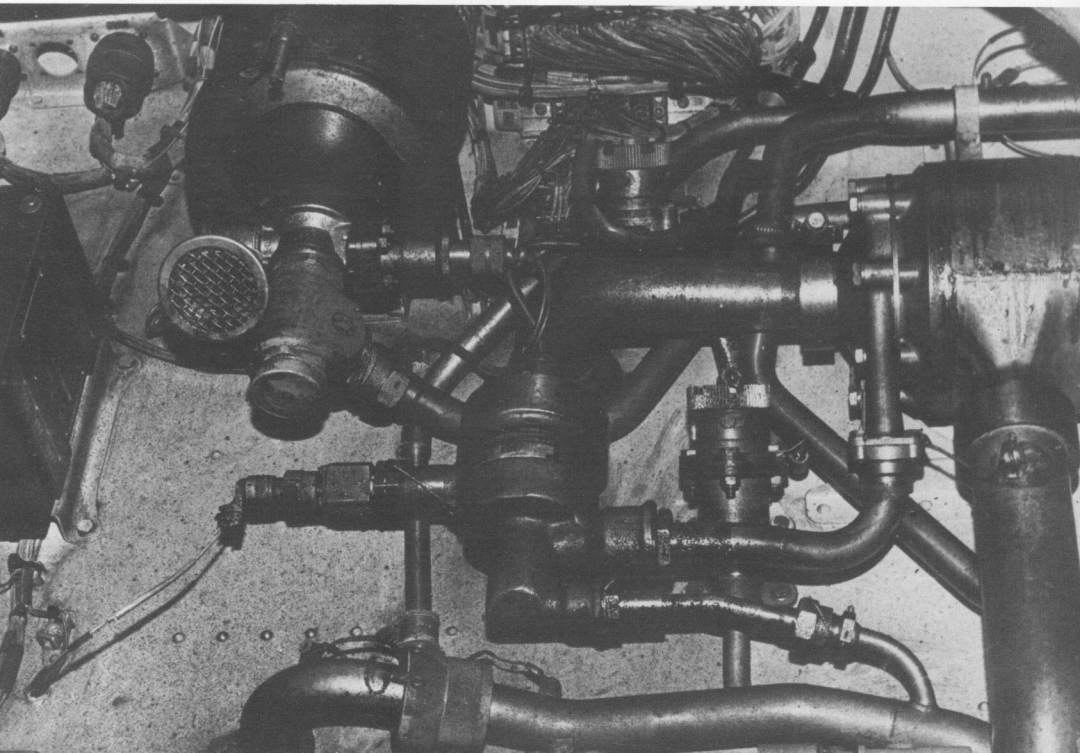

KEEP
CLEAR
599

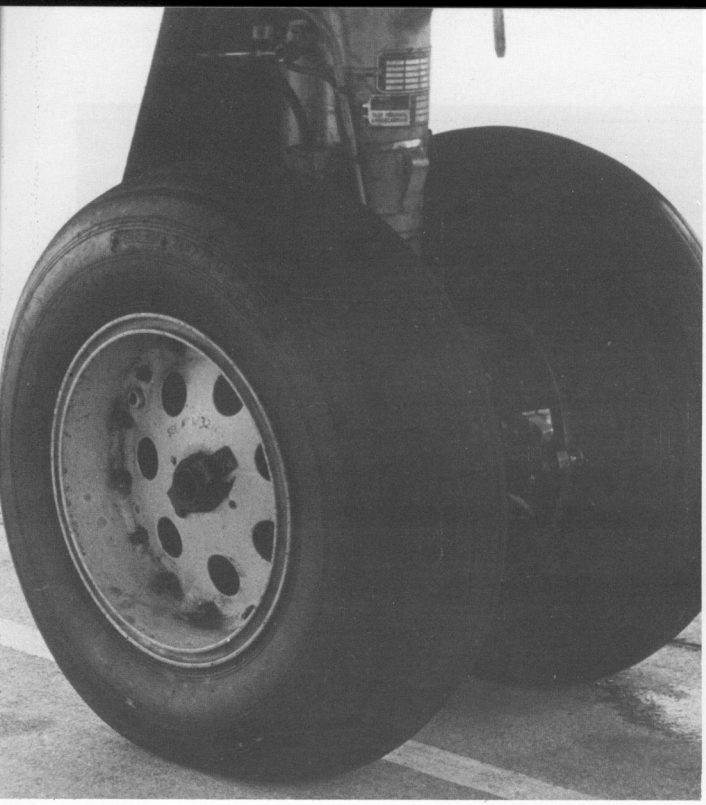


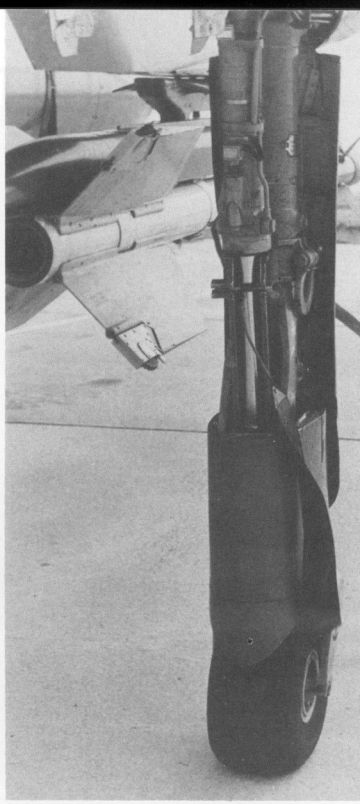

DOORS MANUAL
OPENING VALVE
KEEP CLEAR OF
DOORS ON OPERATION

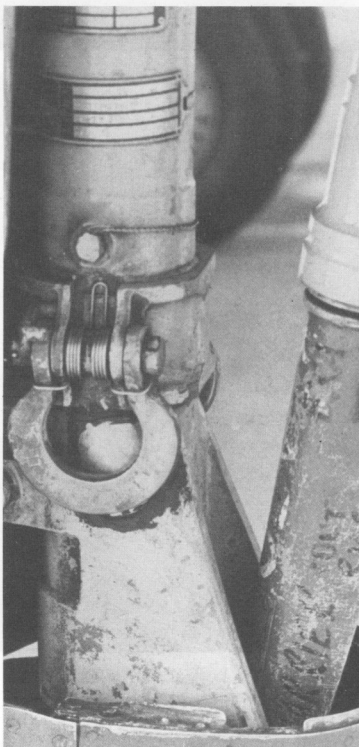

DANGER

Right: The Sea Harrier's characteristic twin mainwheels, hubs here finished in white. Note that only the small forward door is open.
Below: Sea Harrier secrets not often revealed: part of what lies behind the pre-closing mainwheel doors.
Opposite page top left: The main undercarriage from the port side. The tandem layout of the Harrier design is a direct result of the nature of the powerplant: vectored thrust, Pegasus-style, implies a shoulder-mounted wing and hence a fuselage-mounted undercarriage (the possible alternative involves wing nacelles, ruled out on grounds of drag and penalties with weapons fits etc), but one which is remote from the effects of jet efflux. The problem was accentuated by the need for low-pressure (and therefore voluminous) tyres.
Opposite page top right: The 'bicycle' layout of the undercarriage requires stabilising outrigger units: this is the starboard outrigger, from the rear. The bright oleo section contrasts with the grey elsewhere.
Opposite page bottom left: Another view of the starboard outrigger wheel; note the tan-coloured protective plastic guard fitted to the base of the main fairing.
Opposite page bottom right: Detail of port outrigger, with lash-down lug clearly in evidence.



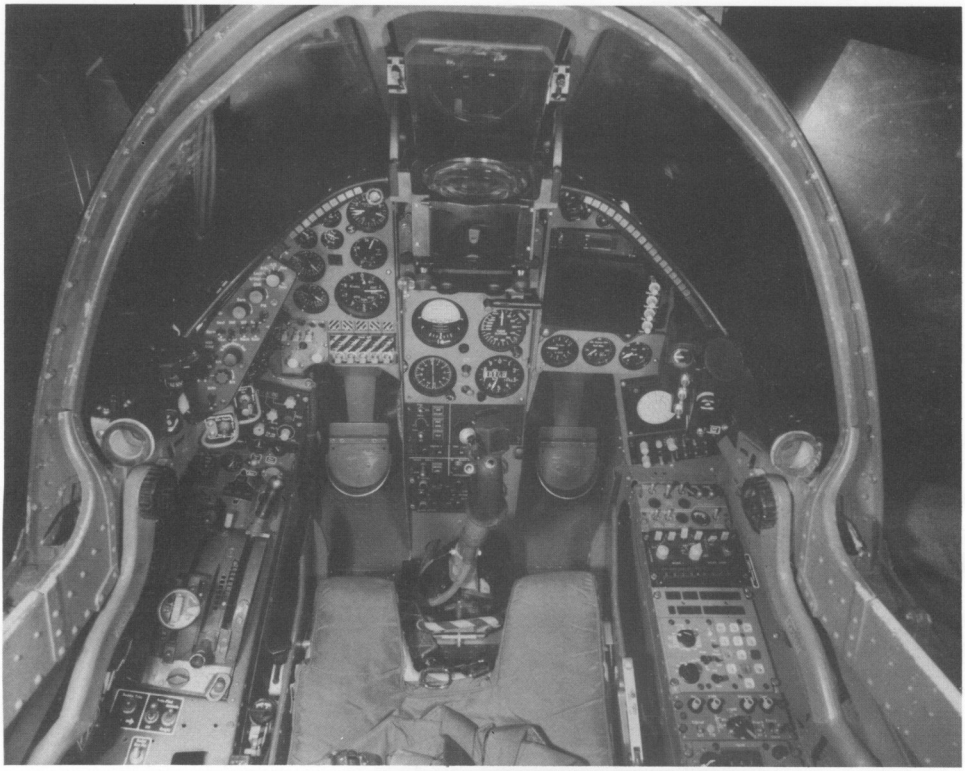


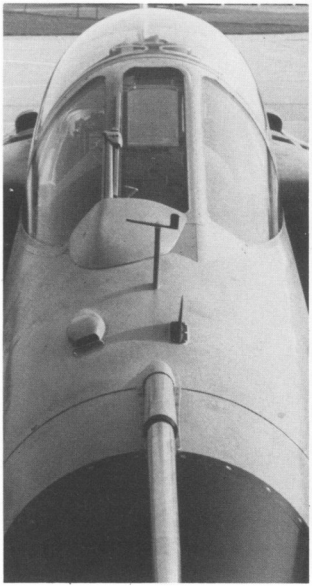


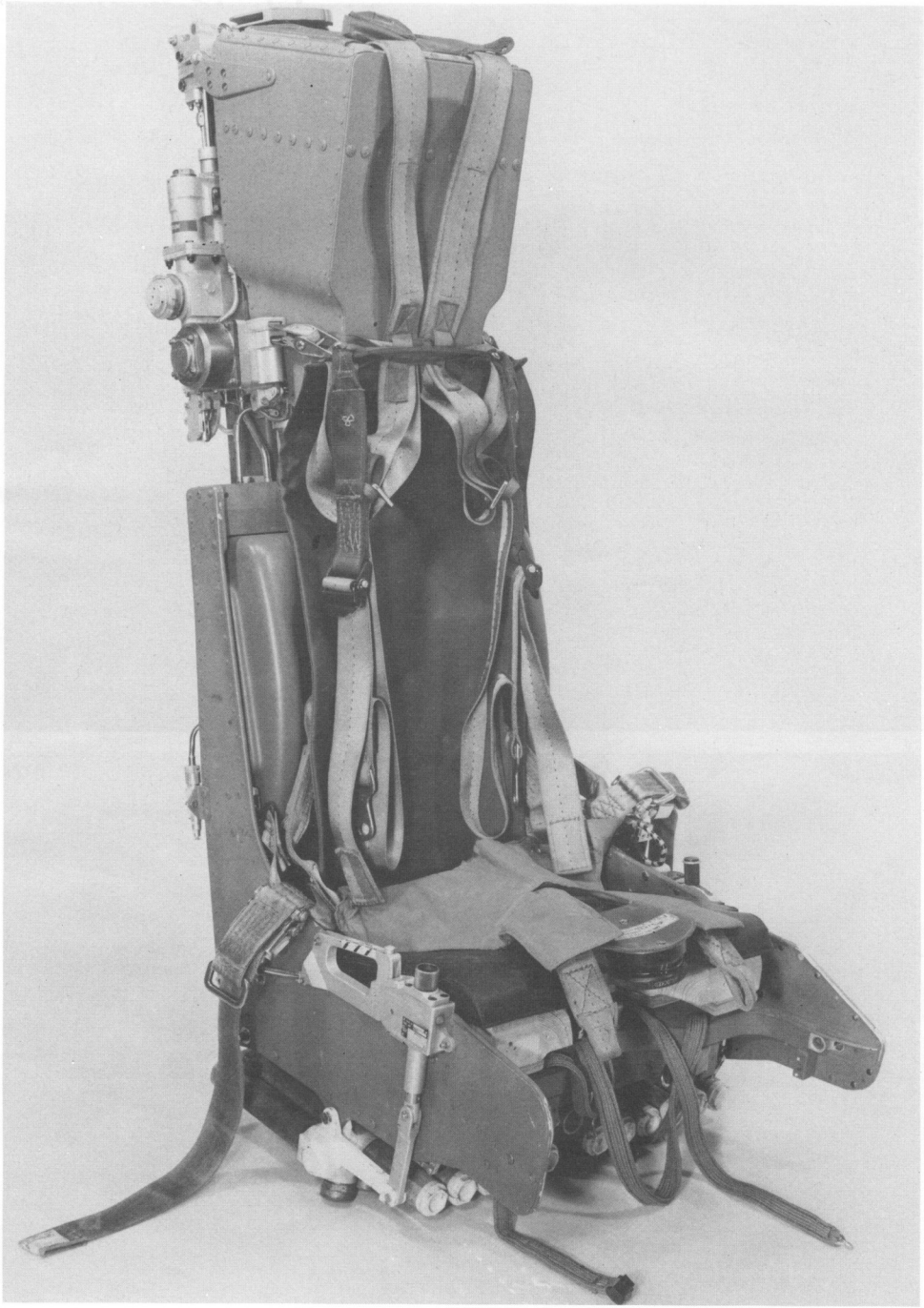


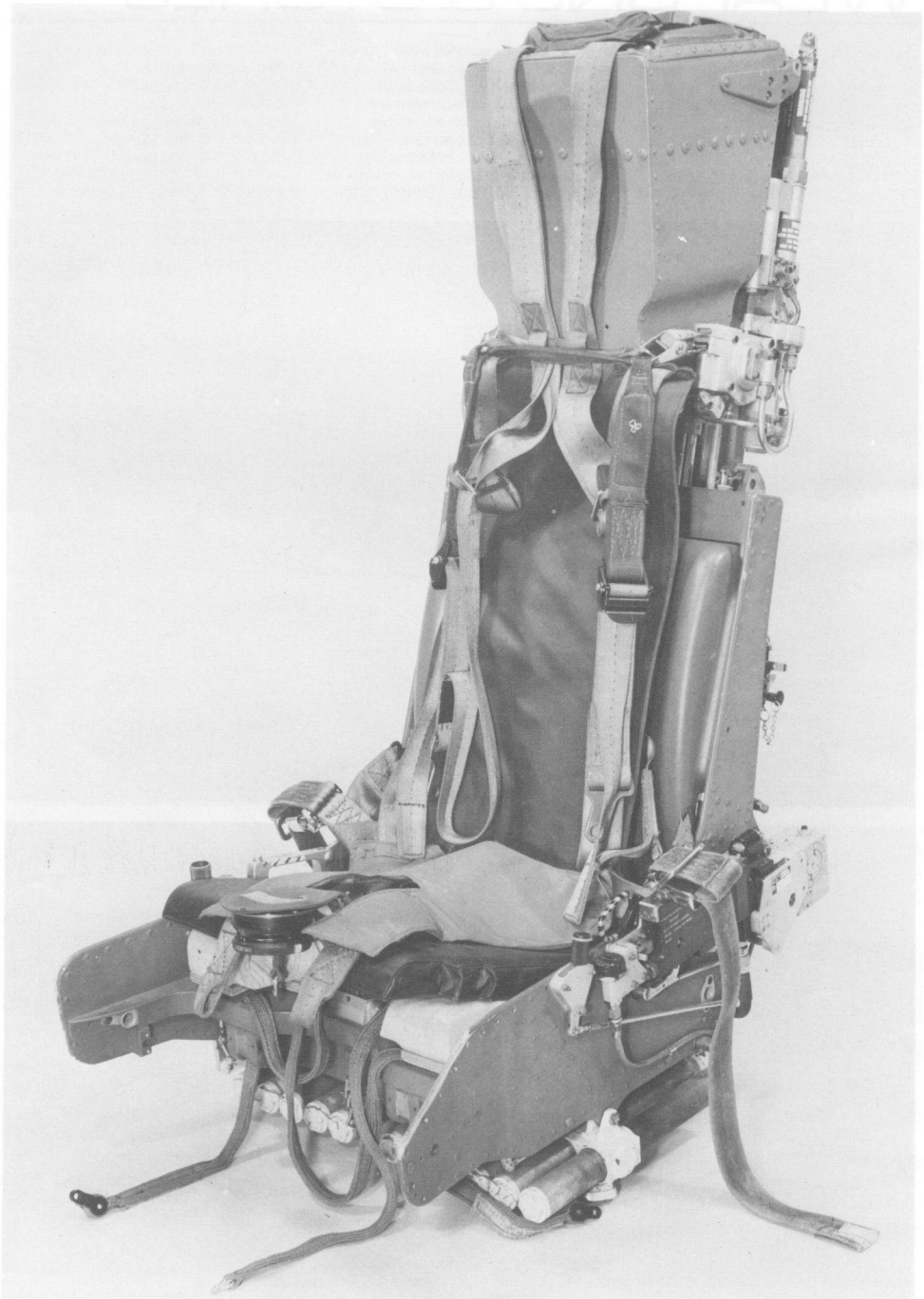
COCKPIT

Below: Windscreen and canopy from the starboard side, with entry ladder in position below. Note Miniature Detonating Cord (MDC) at top of canopy.
Bottom: Canopy from the port side. Visible at extreme right is one of the aircraft's paired intakes for cabin air conditioning.
Opposite page top: Sea Harrier cockpit. The unique feature, the nozzle control lever, is seen in the throttle box, adjacent to the pilot. When positioned fully forward, as here, the nozzles point directly aft. *British Aerospace*
Opposite page bottom left: Head-on view shows shape of windscreen and position of wiper; the shrouding at the base of the latter is purely an aerodynamic feature. *HMS Heron*
Opposite page bottom right: Close-in view showing details around rear of Sea Harrier canopy. *British Aerospace*
Overleaf: Two photographs of the Martin-Baker Type 10H seat installed in Sea Harriers; this example lacks the headpad later fitted. *Martin-Baker Aircraft Co Ltd*

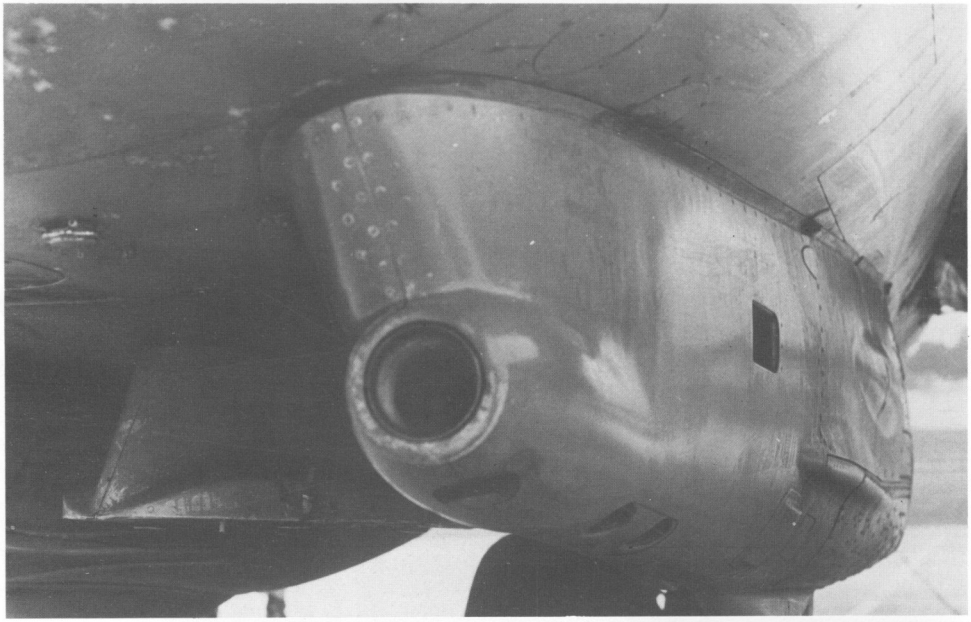


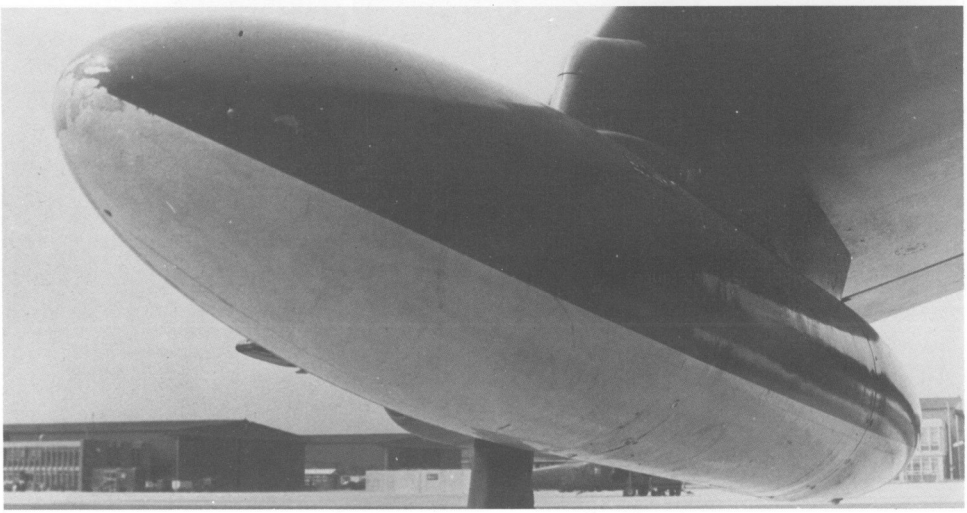


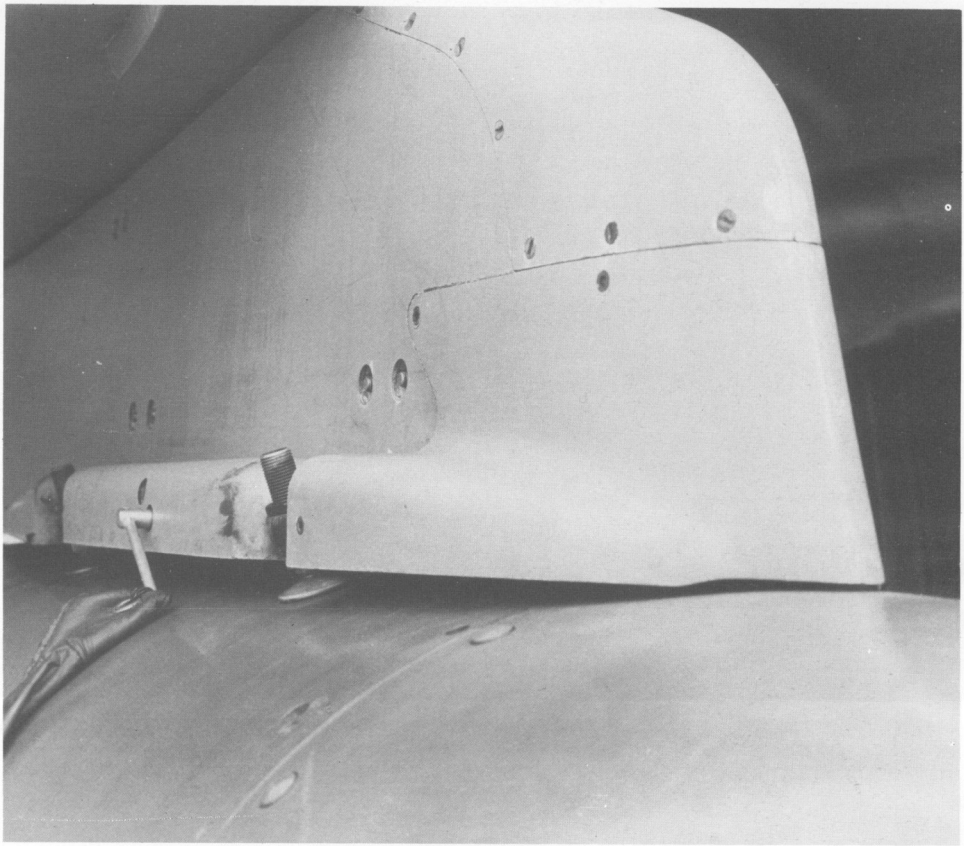


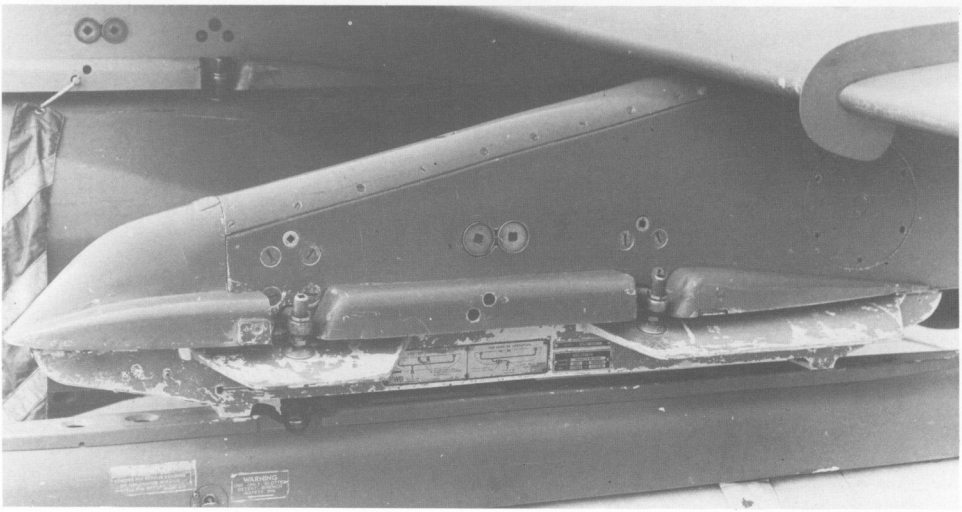


Below: 30mm Aden gun pod, port side. This photo dispels the myth that the Sea Harrier's centreline pylon is never carried when the cannon pods are fitted. Aden muzzles are frequently to be seen covered on static aircraft.
Bottom: Somewhat weathered 100gal tank fitted to inboard pylon of XZ460/ '710', August 1983; the tank is finished in the old colour scheme even though the aircraft is Dark Sea Grey overall.
Opposite page top: Close-up of inboard pylon, the attachment bolts for the drop tank being clearly visible.
Opposite page bottom: Close-up of outboard wing pylon; note that the Sidewinder missile launcher requires an adapter and is not fitted directly to the pylon. The hook pull-ups are clearly visible above the pylon attachment bolts, as are the cartridge locations for explosive release. Inboard pylon, carrying a 100gal drop tank, shows safety pin and RBF tag fitted. When flying without wing pylons, Sea Harriers have aerodynamic fairings fitted over the pylon locations.







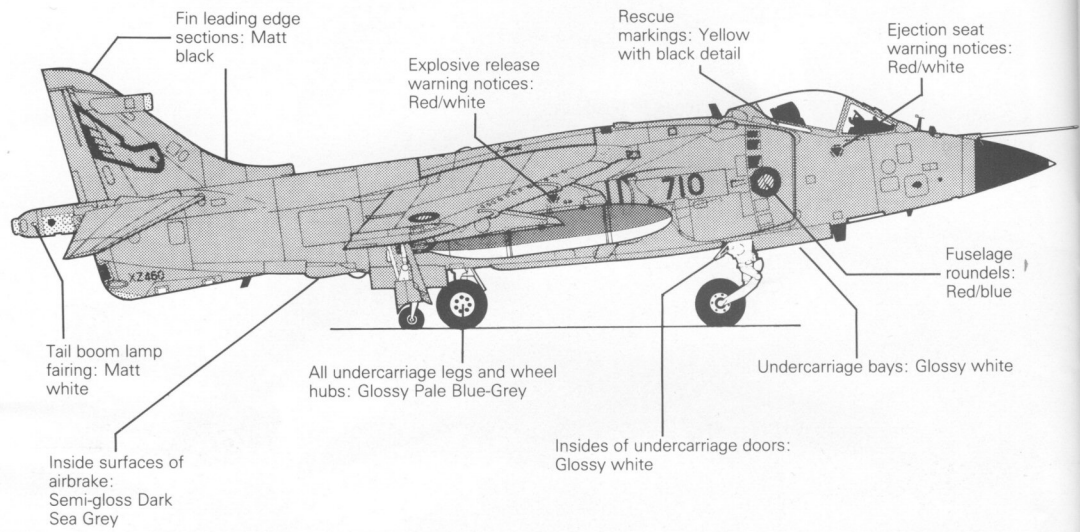


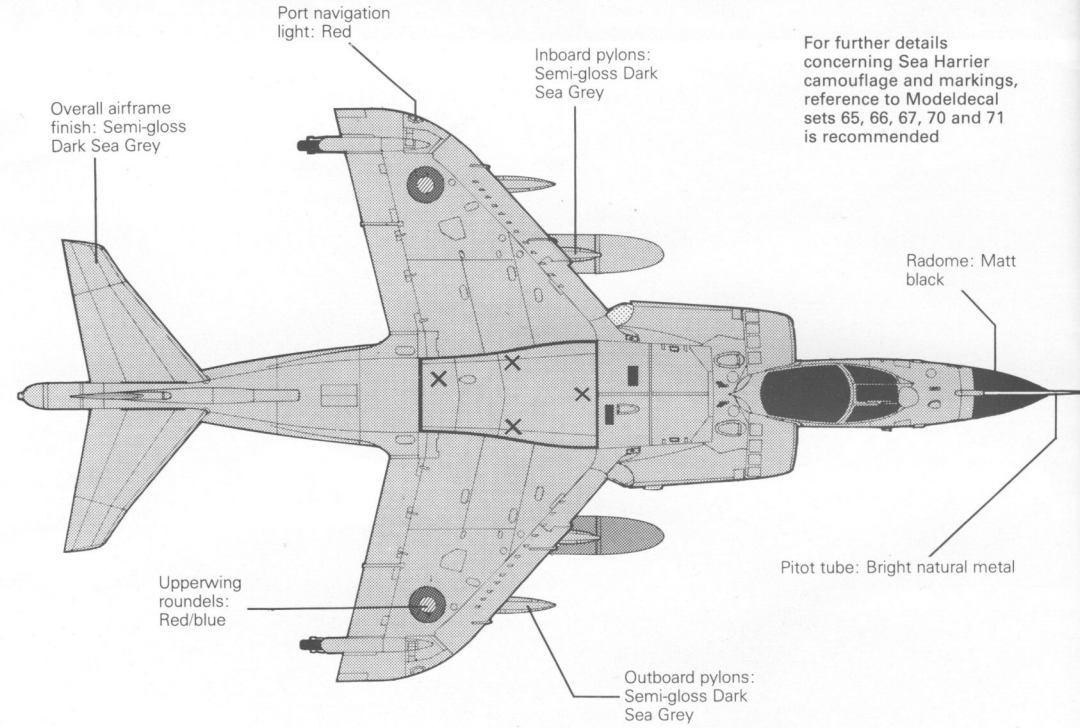
Top: Starboard missile and drop tank stations from aft.
Above: Inboard view of starboard Sidewinder missile (AIM-9L).
Right: Twin AIM-9s can be carried, via a special launcher. *Richard E Gardner*
Opposite page top: The Sea Eagle ASM is being developed for Sea Harriers. *British Aerospace*
Opposite page bottom: Matra 550 Magic AAMs are specified for use by the Indian Navy. *British Aerospace*


H3
NAVY

SCALE COLOUR PLANS

BAe SEA HARRIER FRS Mk 1, No 899 NAS, RNAS YEOVILTON, AUGUST 1983

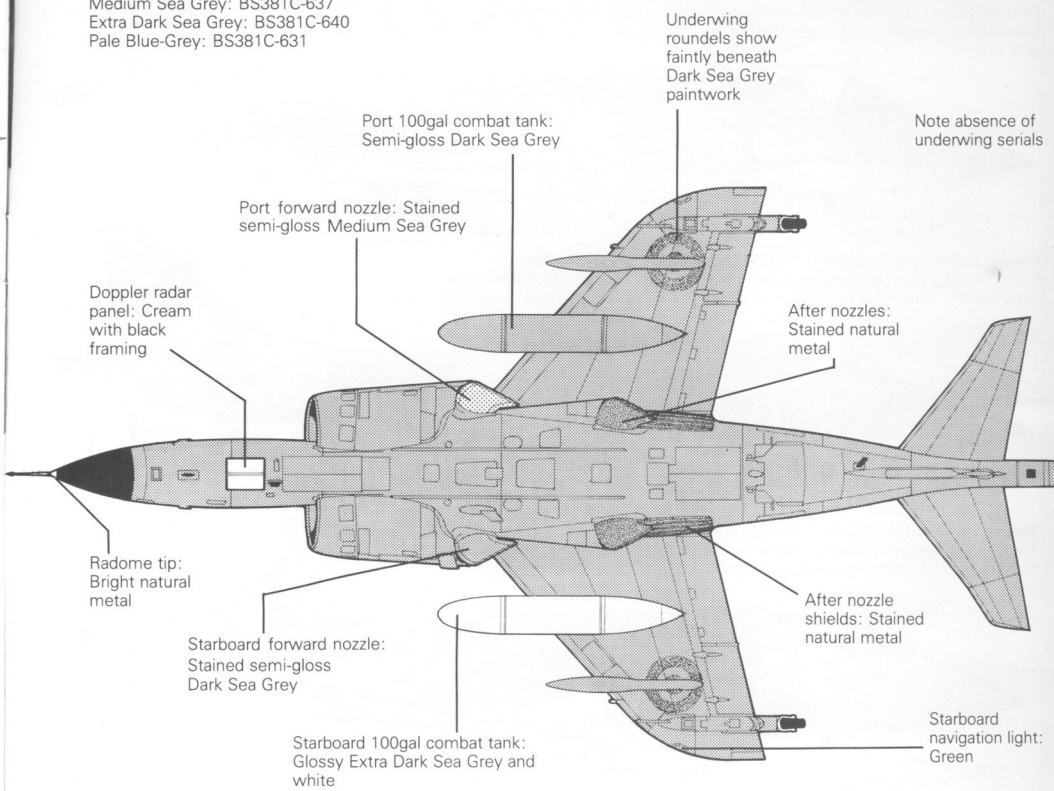




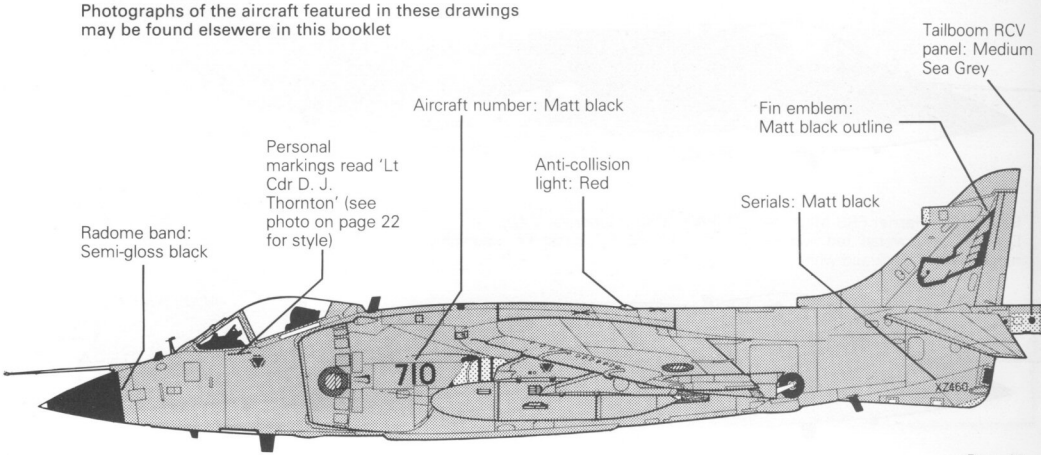
For further details concerning Sea Harrier camouflage and markings, reference to Modeldecal sets 65, 66, 67, 70 and 71 is recommended

British Standard Colour (BSC) references
Dark Sea Grey: BS381C-638
Medium Sea Grey: BS381C-637
Extra Dark Sea Grey: BS381C-640
Pale Blue-Grey: BS381C-631

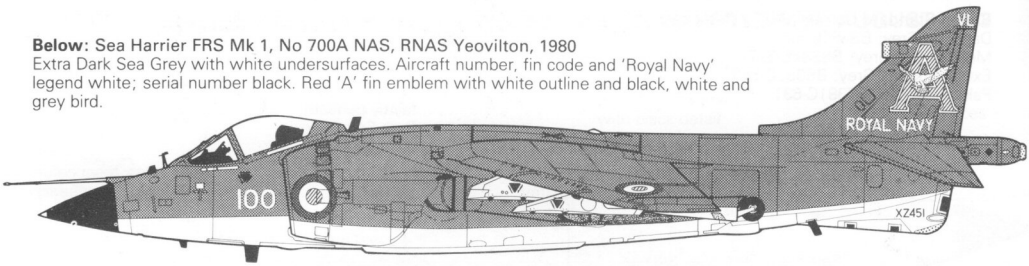
1:72 scale



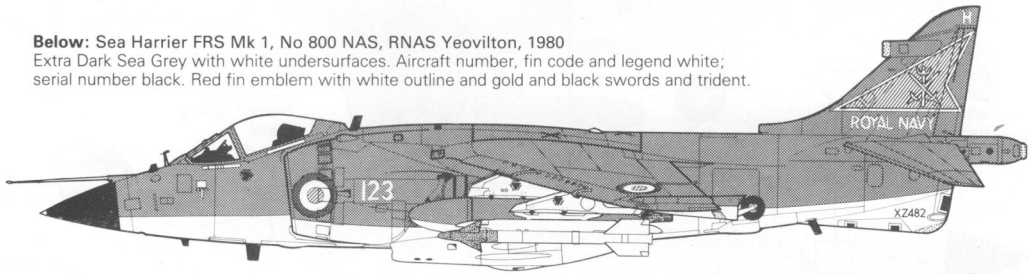
Photographs of the aircraft featured in these drawings may be found elsewere in this booklet



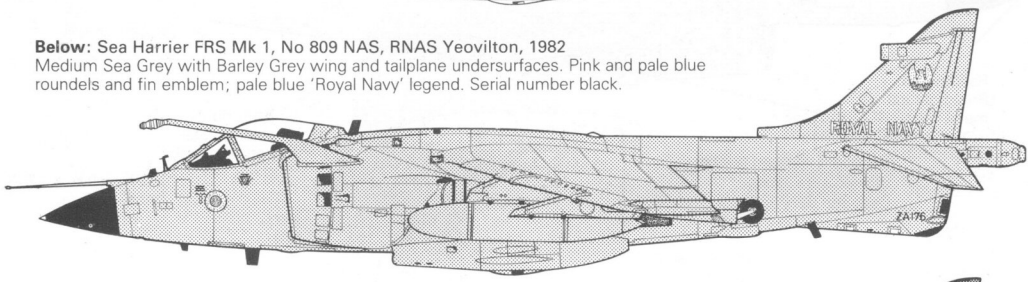
Below: Sea Harrier FRS Mk 1, No 700A NAS, RNAS Yeovilton, 1980
Extra Dark Sea Grey with white undersurfaces. Aircraft number, fin code and 'Royal Navy' legend white; serial number black. Red 'A' fin emblem with white outline and black, white and grey bird.



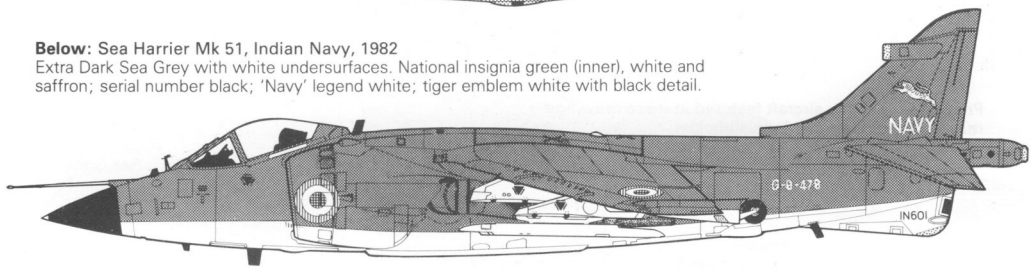
Below: Sea Harrier FRS Mk 1, No 800 NAS, RNAS Yeovilton, 1980
Extra Dark Sea Grey with white undersurfaces. Aircraft number, fin code and legend white; serial number black. Red fin emblem with white outline and gold and black swords and trident.



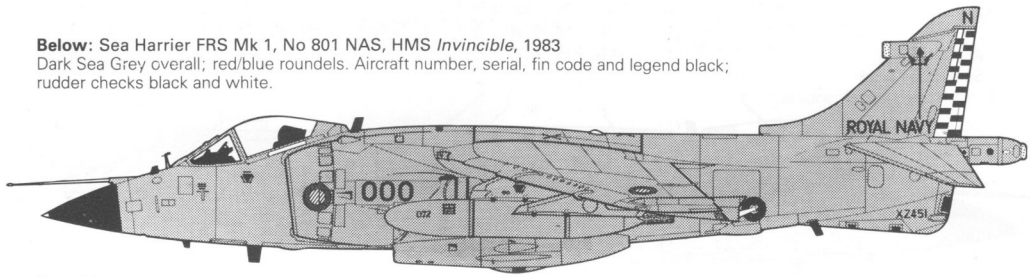
Below: Sea Harrier FRS Mk 1, No 809 NAS, RNAS Yeovilton, 1982
Medium Sea Grey with Barley Grey wing and tailplane undersurfaces. Pink and pale blue roundels and fin emblem; pale blue 'Royal Navy' legend. Serial number black.



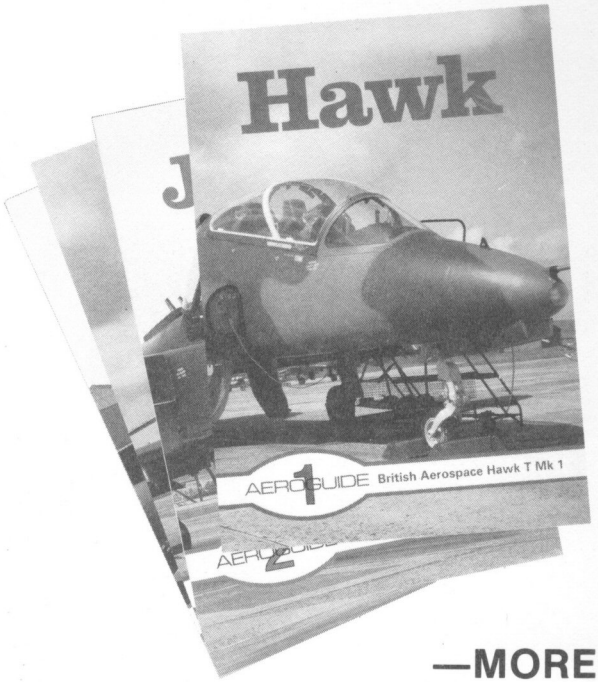
Below: Sea Harrier Mk 51, Indian Navy, 1982
Extra Dark Sea Grey with white undersurfaces. National insignia green (inner), white and saffron; serial number black; 'Navy' legend white; tiger emblem white with black detail.



Below: Sea Harrier FRS Mk 1, No 801 NAS, HMS *Invincible*, 1983
Dark Sea Grey overall; red/blue roundels. Aircraft number, serial, fin code and legend black; rudder checks black and white.



AEROGUIDES



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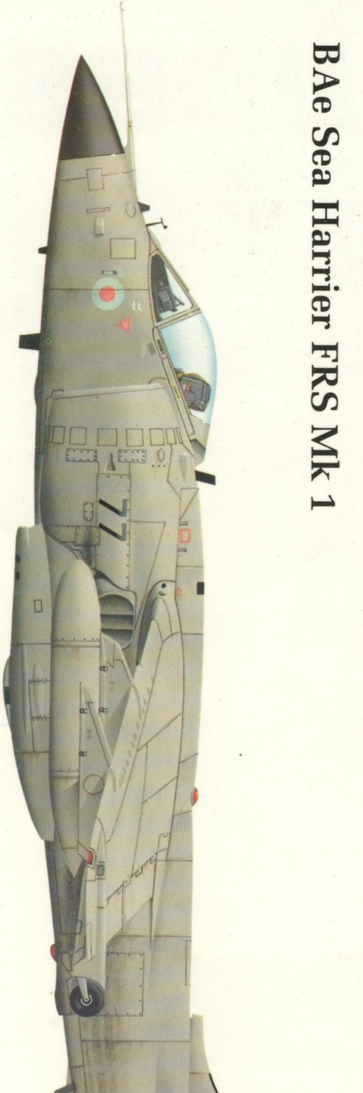
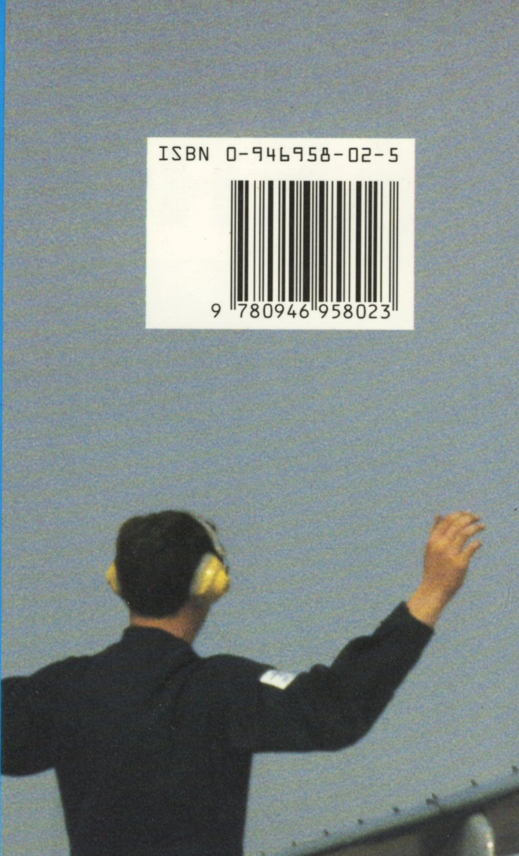
BAe Sea Harrier FRS Mk 1





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